Chapter IV.—THE FAUNA CONSIDERED BY SYSTEMATIC GROUPS.

1. PROTOZOA.

This phylum is represented in our list by 99 determined species, together with 5 others which are entered as undetermined or doubtful. Of the 99 determined species 32 are assigned to the Rhizopoda, 2 to the Heliozoa, 21 to the Mastigophora, 38 to the Ciliata, 5 to the Suctoria, and 2 to the Sporozoa. All but 2 of the rhizopods belong to the subclass Foraminifera, of which 23 species have been encountered during our dredging, and a number of others collected on piles, etc. With the exception of two or three species, no Foraminifera had been recorded for local waters prior to the operations of the present survey.

The data which we have utilized relative to the Protozoa are derived mainly from two sources. The Foraminifera were obtained during the dredging operations of 1905 and 1907, and were, without exception, identified by Dr. J. A. Cushman, of the museum of the Boston Society of Natural History. A nearly complete list of these species has already been published by Dr. Cushman (1908). The records for the other divisions were taken from the report of Calkins (1902) upon the marine Protozoa of the region, to which have been added a very few data from the writings of Peck (1894 and 1896). In our annotated list the classification which we have adopted is that of Professor Calkins, except in the case of the Foraminifera. For the treatment of the latter group Dr. Cushman is responsible.

The local records for Protozoa are comparatively scanty. The report of Calkins represents the search of one investigator for a period of two months during the midsummer alone. With very few exceptions, the forms listed were taken from the local pier, close to the laboratory building. Nevertheless, as a result of this somewhat superficial examination, Calkins was able to record 72 species, 8 of which were described as new to science.[a]

No search was made for Foraminifera during the summers of 1903 and 1904, though *Discorbina rosacea* was noted on several occasions without its identity being recognized. Dr. Cushman's presence at the Woods Hole laboratory during the season of 1905 directed our attention to these organisms, and bottom samples from most of the stations of that year were examined by him personally. The dredging during that season was restricted to Vineyard Sound (*Fish Hawk*) and the eastern shore of Buzzards Bay (*Phalarope*). Two years later, in order to obtain more complete records for the Foraminifera and certain other organisms, about 25 of the *Fish Hawk* stations in Vineyard Sound and about 30 of those in Buzzards Bay were revisited. Bottom samples from all these points were submitted to Dr. Cushman, who was thus enabled to provide us with important supplementary data. Only two species were found, however, which had not previously been recorded by us, and it is Dr. Cushman's belief that the list of local Foraminifera is tolerably complete. But our knowledge of their distribution within the region was greatly extended by these later dredgings. We have accordingly departed from the custom, which has been followed for most other groups, of including in our distribution charts

[a] Two of these are no longer regarded by Dr. Calkins as good species.

only data derived from the regular dredging operations of the first three years, and have plotted out the records of these supplementary dredgings in the case of the Foraminifera.

The meager representation of the Foraminifera in our local fauna is realized in a striking way when the present records are compared with those for deep-sea dredging. There occurs in these waters none of the "ooze" which forms such a marked feature of the ocean bottom the world over. The maximum number of species found by the survey at any single station was 9 (*Phalarope* station 78), and the average number found throughout the period during which a careful examination was made [a] was 1.4 species per dredge haul. During the *Challenger* dredgings, it was not uncommon to find 100 species of Foraminifera at a single station, and over 240 species were found in one case.

The Canadian list of Whiteaves comprises 64 members of this group, 13 of which are known to occur in our local waters; while the Plymouth list comprises 109 species, 19 of which are common to Woods Hole. The list for the Irish Sea comprises 209 species of Foraminifera. All three of these foreign surveys have extended to waters of considerably greater depth than any which occur within the "Woods Hole region" of the present report. The great disparity in the wealth of Foraminifera is thus largely accounted for.

Distribution charts have been plotted for those 9 of our local species which were taken at 10 or more of the dredging stations. Regarding the distributions here portrayed few definite conclusions can be offered, owing to the incompleteness of the records upon which they are based. As already stated, these organisms were not looked for during the regular dredgings of the *Fish Hawk* in Buzzards Bay, nor during the *Phalarope* dredging in Vineyard Sound, though the former deficiency was in some measure rectified during the summer of 1907. As a consequence, one might easily be misled respecting the relative abundance of certain species on various parts of the local sea floor. For example, most of the species seem to be scarce or absent in the central parts of Buzzards Bay. This is doubtless due in part to the fact that material was examined from less than 30 stations in the deeper parts of the Bay, as compared with about 125 in the Sound. During the supplementary dredging of 1907 a number of species (*Miliolina seminulum, Polymorphina lactea, Polystomella striatopunctata*, and *Rotalia beccarii*) were encountered at *Fish Hawk* stations in the Bay; the two last named, indeed, being taken with considerable frequency. It does not seem unlikely, however, that the soft, black mud which prevails throughout much of Buzzards Bay is unfavorable to some species of Foraminifera, as to many other organisms of all sorts. On the other hand, with a very few exceptions, every species which was recorded from Vineyard Sound was taken with greater or less frequency along the island shores of Buzzards Bay.

One feature in the distribution of nearly all the species which have been plotted is the greater frequency with which they occur at the western end of Vineyard Sound. Indeed, certain species are entirely lacking in the eastern half. So far as is known, the same degree of care was taken in preserving and examining the bottom samples throughout the whole length of the Sound during the *Fish Hawk* dredging of 1905. This greater abundance of Foraminifera at its western end would thus seem to be a genuine fact in distribution. Whether it is due to the character of the bottom, which is predominantly sandy in the western half of the Sound, or to the comparative absence of the swift tidal currents in the latter part can not be stated with any certainty.

[a] Including only the *Fish Hawk* and *Phalarope* stations of 1905.

The following is a list of the Foraminifera dredged by the Survey. The asterisk denotes species which were recorded from 10 or more stations:

Astrorhiza limicola.
Reophax dentaliniformis.
Haplophragmium canariense.
Webbina hemispherica.
Spiroculina limbata.
*Biloculina ringens (chart 1).
Biloculina tubulosa.
*Miliolina seminulum (chart 2).
*Miliolina oblonga (chart 3).
*Miliolina circularis (chart 4).
Miliolina boueana.
Miliolina venusta.
Miliolina bicornis.
Verneuilina polystropha.
*Polymorphina lactea (chart 5).
Polymorphina concava.
Polymorphina rotundata.
*Discorbina rosacea (chart 6).
Truncatulina lobatula.
*Pulvinulina lateralis (chart 7).
*Rotalia beccarii (chart 8).
*Polystomella striatopunctata (chart 9).
Polystomella crispa.

2. PORIFERA.

The treatment of the sponges constitutes decidedly the weakest spot in our report. In addition to the naturally great difficulties presented to the systematist by these animals is the fact that the group has been very largely neglected by local zoologists. Since the work of Verrill in the early seventies, in which a considerable proportion of the forms recorded were not specifically determined, no attempt has been made to list or describe the sponges of the shallower waters of the New England coast. Verrill's later studies were devoted to species taken at considerable depths and belonging to a fauna quite distinct from that under consideration. Lambe,[a] it is true, has given much attention to the Canadian sponges, some of which are identical with species included in the present work, and H. V. Wilson[b] has reported upon the Porto Rico forms, none of which, however, are known to occur in the Woods Hole region. The paucity of our data relating to the shallow-water species constitutes a conspicuous gap in our knowledge of the local fauna.

In view of this condition of affairs, Dr. J. A. Cushman, of the museum of the Boston Society of Natural History, undertook during the summer of 1905 and during the following winter to identify the sponges collected in the course of the Survey dredging. Twelve species were specifically determined by him with more or less certainty, four of these being forms which had been overlooked or left unidentified by Verrill at the time of the writing of the "Report upon the Invertebrate Animals of Vineyard Sound." Certain other species were provisionally assigned to genera, and an even greater number remained undetermined. It was unfortunately impossible for Dr. Cushman to continue this work after 1905, and thus the results here presented are fragmentary and perhaps not wholly consistent.

In all, 14 determined species of sponges are comprised in our annotated list, the identity of which is not certain in all cases. We have also included, on the authority of Verrill and of Cushman, a number of unidentified forms, to which generic names have been provisionally assigned.

The Canadian list of Whiteaves comprises 36(+2?) species of Porifera (identified in the main by Lambe), six of which are common to our Woods Hole list. At Plymouth only 18 sponges have been catalogued, of which four or five are common to our own

[a] Sponges from the Atlantic coast of Canada. Transactions of the Royal Society of Canada, vol. II, sec. IV, 1896, p. 181–211.
[b] Bulletin of the U. S. Fish Commission, vol. XX, 1900 (1902), p. 375–411.

waters.[a] Herdman records 58 species from the Irish Sea, while Graeffe lists 45 species from the Gulf of Trieste. As implied in the foregoing discussion, it is likely that the Woods Hole list will be greatly extended by further investigations.

Referring to our dredging records for this group, the distributions of certain forms, such as *Cliona celata, Microciona prolifera, Tethya gravida,* and *Polymastia robusta,* have probably been ascertained with a fair degree of accuracy. On the other hand, it is probable that some confusion occurs between the two species of *Chalina,* since specimens which were listed in the field records as *C. arbuscula* were in a number of cases subsequently identified as *C. oculata* (see catalogue). For this reason a single chart has been prepared, which includes all the records for this genus. A similar confusion exists regarding the two species of *Halichondria* (*H. panicea* and *H. caduca*). And in addition to these equivocal records specimens belonging to entirely undetermined species of this genus are listed from about 20 of the regular dredging stations and were doubtless taken at many others.

Under such circumstances little of a general nature can be said regarding the distribution of these animals in local waters. The species having the most general occurrence was *Cliona celata* Grant (=*Spongia sulphurea* Desor), which was recorded from 171 of the regular stations. This form seems to flourish nearly as well on one kind of bottom as another, though it is much less common in the western half of the Sound than in the eastern half.[b] That its scarcity in the former region is not due to the lower summer temperature of the water there is rendered probable by the fact that this species has been reported by Lambe from Prince Edward Island, in the Gulf of St. Lawrence. It has not been taken by us, however, at Crab Ledge, where many of the typical cold-water species occur and many southern ones are lacking.

Microciona prolifera is not uncommon in the Sound in the form of reddish incrustations on the surface of stones and shells. In Buzzards Bay, particularly in the inshore waters, it frequently grows up into the characteristic and beautiful arborescent form.

A species of *Grantia,* which has been regarded as *G. ciliata* (Fabricius) by Verrill and others, is common on piles, and one or more species of the same genus (not improbably identical with the foregoing) were encountered at various points in dredging (chart 10).

An interesting case of restricted distribution is exemplified in the case of *Polymastia robusta,* for which, however, no chart has been prepared, owing to the limited number of stations from which it was recorded. This readily recognizable species was taken by us a few times at the western entrance of Vineyard Sound and in the mouth of Buzzards Bay; likewise at five of the seven regular stations of the survey at Crab Ledge. It is thus a representative of that colder water fauna which just enters the limits of our region. So far as we know, this species has not been listed from points farther south upon our coast than Marthas Vineyard, though ranging northward at least to the Gulf of St. Lawrence.

Another case of definitely restricted distribution, for which, however, no explanation can be offered at present, is that of *Tethya gravida.* This species, which was first described by Hyatt from specimens taken in Buzzards Bay, was encountered by us eight times,

a It is stated by the authors that "the list is a very imperfect one, many common species not having been identified and recorded."

b The chart for this species likewise shows a considerable gap in the central region of the Bay, but specimens were later taken at several points in this area.

but always within a very limited area near the head of the Bay. Mr. G. M. Gray also reports finding it at Bird Island, in the same vicinity. We know of no other records of the occurrence of this species.

The following is a list of the species recorded from the Survey dredgings. The asterisk denotes those which were taken at 10 or more of the stations (exclusive of Crab Ledge).

Ascortis fragilis.
?*Grantia ciliata (chart 10).
*Cliona celata (chart 11).
Polymastia robusta.
Tethya gravida.
Halichondria panicea.
Halichondria caduca.
Chalina arbuscula.
Chalina oculata.
Esperella modesta.
Desmacidon palmata.
Myxilla sp. undet.
*Microciona prolifera (chart 13).

A chart (12) has been prepared based upon the equivocal records for one or both species of *Chalina*.

Of the three determined species so common as to have been recorded from 10 or more stations, one appears to be distinctly northern, another to be distinctly southern, while the third appears to have a range of nearly equal extent in both directions. The ranges, as given by Verrill (1873), are as follows:

Grantia ciliata: Rhode Island to Greenland.
Cliona celata: South Carolina to Portland, Me.
Microciona prolifera: South Carolina to Cape Cod.

Cliona, as already stated, has since been reported from the Gulf of St. Lawrence.

3. CŒLENTERATA.

Our list comprises 160 determined species belonging to this phylum, together with 12 others which are undetermined or doubtful. These are assignable to 54(+3?) families and 98(+7?) genera. The representation of the various classes is as follows: Hydrozoa, 132(+8?); Scyphozoa, 5(+1?); Actinozoa, 14(+3?); Ctenophora, 8. Among these, 28(+1?) of the Hydrozoa and 4(+2?) of the Actinozoa have been encountered during the Survey dredgings. The Scyphozoa and Ctenophora, owing to their pelagic mode of existence, do not figure in the dredging records, although the latter frequently and the former occasionally were taken during the reeling in of the dredge or trawl. Furthermore, a large majority, even of the fixed hydroids, comprised in our catalogue, find their proper habitat in shallower waters, where they grow attached to plants or woodwork, and are rare or absent upon the bottoms reached by the dredge.

The identification of specimens concerning which any doubt was felt by the collectors was made by Prof. C. W. Hargitt, of Syracuse University, and Prof. C. C. Nutting, of the University of Iowa, to whom we again take occasion to express our thanks for their assistance. The identification of the 1903 specimens was performed by Prof. Nutting, that of the subsequent material by Prof. Hargitt. A comparison of the determinations made by these two authorities revealed certain differences of opinion, some of which were later adjusted. In other cases, such differences are indicated in the text. Prof. Hargitt was present at the laboratory as a member of the investigation staff during the summers of 1905 to 1909, inclusive, and the records for those seasons are doubtless on this account more complete than during the two previous seasons of the Survey's

work. During these two earlier seasons it seems probable that certain minute and inconspicuous forms were overlooked by the collectors. It is likewise probable that some closely related species were confused in the field records. This is perhaps true to some extent even of such common forms as *Eudendrium ramosum* and *E. dispar*, though samples from many of the stations were fortunately preserved for future reference.

The apparent scarcity of nearly all hydroids throughout Buzzards Bay, as portrayed by the distribution charts, may be due in some measure to the fact that no specialist in this group was present during the season of 1904, when the original *Fish Hawk* dredging was carried on in that body of water. We are, however, inclined to attribute a minor importance to this fact in judging of the occurrence of hydroids in Buzzards Bay, since records from 29 stations which were redredged in 1909 do not materially affect our ideas regarding the local distribution of these organisms.

The data utilized in the preparation of our catalogue, aside from those derived from our own collecting operations, are based principally upon the published works of A. Agassiz (1865), Verrill (1873), Nutting (1901), and Hargitt (1901–1908). In addition, special records were furnished by members of the investigation staff or by others. Particular mention must be made of some rather extensive manuscript notes kindly contributed by Prof. Hargitt. The latter authority likewise consented to revise our annotated list in respect to nomenclature and classification, though he regards these as being still to a considerable extent provisional.

About 20 species new to science have been described during the past 10 years by Hargitt, Nutting, Mayer, and others from specimens taken within the limits of the present region. At least two of these (*Ectopleura prolifica* Hargitt and *Keratosa complexum* Hargitt) were described from specimens obtained during the course of the survey dredging; while a number of them were first collected and described during this same period, though independently of the dredging operations. Still other species (*Calyptospadix cerulea, Opercularella pumila, Sertularia versluysi, Sertularella polyzonias, Aglaophenia minuta, Tealia crassicornis*), though more or less familiar elsewhere, have been added to the known fauna of these waters through the dredging and collecting operations which form the chief subject of the present volume.

Verrill and Smith (1873) recorded 72 determined species of coelenterates from definitely stated points within the limits of the region, together with a considerable number of others which were doubtful, undetermined, or extralimital. Among the foregoing 72 species were 57 Hydrozoa, 3 Scyphozoa, 8 Actinozoa, and 4 Ctenophora. Certain of the species listed by Verrill (e. g., *Halecium gracile, Edwardsia farinacea*, and *E. lineata*) do not appear to have been encountered in local waters by later naturalists. Indeed, repeated search by our parties for *Edwardsia lineata* at points where it was said to be abundant by Verrill failed to bring to light a single specimen. On the other hand, certain species which were not listed at all in the "Invertebrate Animals of Vineyard Sound" are now known to be common in these waters. Such are *Podocoryne carnea, Lizzia grata, Tubularia couthouyi, Staurostoma laciniata, Epenthesis folleata, Halecium halecinum, Gonionemus murbachii*, and *Sagartia luciæ*. The last-named species we know to be a recent immigrant into these waters, which probably arrived here within the past 15 years. Indeed it has, during this briet period, become by far the most abundant of our local actinians. Whether or not any of the other species are

immigrants of recent standing can not be stated. We have no satisfactory evidence that such is the case.

The Canadian list prepared by Whiteaves includes 66 Hydrozoa, 5 Scyphozoa, 44 Actinozoa, and 4 Ctenophora. Of these, 41 Hydrozoa, 2 Scyphozoa, 4 Actinozoa, and 4 (all) of the Ctenophora are common to our Woods Hole list. It is interesting that while the number of hydroids in the Canadian list is only half as great as in our own, the number of actinians is about three times as great.

The catalogue for Plymouth includes 121 Hydrozoa, 8 Scyphozoa, 34 Actinozoa, and 3 Ctenophora. Of these, 34 (+6?) Hydrozoa, 2 (?) Scyphozoa, (2+1?) Actinozoa, and 2 Ctenophora are known to be common to the Woods Hole region.

The list of Herdman for the Irish Sea comprises 129(+1?) Hydrozoa, 6 Scyphozoa, 24 Actinozoa, and 4 Ctenophora. There is a rather close agreement between the Woods Hole, Plymouth, and Irish Sea lists in respect to the number of Hydrozoa comprised. On the other hand, both of the latter lists agree in including a considerably greater number of actinians than have been recorded from the Woods Hole region.

For the Gulf of Trieste, Graeffe catalogues 64(+2?) Hydrozoa, 9 Scyphozoa, 29 Actinozoa, and 5 Ctenophora.

In all these comparisons the differences in area and in bathymetric range among the various regions must of course be kept in mind (see p. 87).

On the average 1.8 species of cœlenterates were recorded for each of the 458 regular stations of the Survey. The species found to be of most general occurrence was the coral *Astrangia danæ*, which was encountered at 158 of the stations, this being the only cœlenterate which was so prevalent as to be recorded from one-fourth of the stations dredged. It is likely, however, that *Hydractinia echinata* was actually present in at least one-fourth of the dredge hauls, and that it was frequently overlooked by us in listing the species in the field.

Referring to the table on page 78, it will be seen that on the average nearly three times as many species of hydroids per dredge haul were recorded for the *Fish Hawk* stations in Vineyard Sound as for those in Buzzards Bay, while the average number of Actinozoa was the same in both bodies of water. The *Phalarope* stations in Vineyard Sound likewise show an excess of hydroids as compared with the stations in the Bay. From the table on page 79 it is evident that there is a greater wealth both of hydroids and of actinians on bottoms of gravel and stones than upon bottoms of mud or of pure sand. As respects Hydrozoa, the average number of species is nearly twice as great upon sandy bottoms as upon muddy ones. The distribution of most cœlenterates upon the local sea floor is, we believe, almost wholly conditioned by the character of the bottom.

Charts have been prepared showing the distribution, in local waters, of 10 species of Hydrozoa and 3 of Actinozoa. A list of these, with a statement of the geographical distribution of each is given below. Owing to the probable incompleteness of our earlier records for the Hydrozoa, the practice of basing our charts upon the original dredgings of the "regular" series only has not been adhered to for this group. The results of various supplementary dredgings (see p. 62) have been incorporated here as in the case of the Foraminifera and the Bryozoa.

These charts nearly all agree in showing the paucity of cœlenterate life in Buzzards Bay, to which reference has already been made. In fact, but two species (*Eudendrium ramosum* and *Astrangia danæ*) appear to be of anything like as general occurrence in the Bay as in the Sound. Two species among those charted were not recorded from a single station in the former body of water, while some of the others are confined within its limits to the extreme lower end or to the immediate neighborhood of land. This last condition is found to obtain in the case of many species belonging to nearly every group which do not thrive upon muddy bottoms, and their distribution is readily explainable by reference to this fact. Hydroids, as is well known, depend for support upon a solid substratum, such as is afforded by stones or dead shells, and their frequent occurrence upon bottoms which are listed as of pure sand is doubtless made possible by the presence of shells. Where such solid objects occur in the Bay, however, they are commonly more or less covered by soft mud. Nevertheless, at least one species of hydroid, *Eudendrium ramosum*, has established itself in considerable abundance on the floor of Buzzards Bay, a fact which is difficult to explain when we consider the almost total absence there of *Pennaria tiarella*, a species having a quite similar mode of life, and one which is abundant throughout the Sound.

Of considerable interest is the scarcity of *Hydractinia echinata* over the whole central area of Buzzards Bay. That this is not due to the scarcity within this area of the hermit crabs upon whose shells *Hydractinia* commonly dwells may be seen by reference to charts 109, 111 and 112, from which it is evident that the three commonest local Paguri are present throughout the entire Bay. It was at first thought possible that the non-appearance of this hydroid in the records of the *Fish Hawk* for Buzzards Bay might have been due to the failure of those responsible for the latter series of stations to include it when listing the contents of the dredge. That this is not a satisfactory explanation was shown in the course of some supplementary dredgings made during the summer of 1909. Hermit crabs (*P. longicarpus* and *P. annulipes*) were taken at 16 of the former *Fish Hawk* stations, but in only a single instance was *Hydractinia* met with, though *Podocoryne* was noted three times.[a]

Several of the hydroids, particularly *Tubularia couthouyi* and *Thuiaria argentea*, appear to show a marked preference for the eastern half of Vineyard Sound, where the bottom is in large measure stony. The distribution of *Obelia geniculata* is probably dependent upon that of certain algæ, to which it is generally found attached. Its abundance in the vicinity of Gay Head probably stands in direct relation to the occurrence there of large numbers of the kelps (*Laminaria*), upon which it frequently grows.

At least two very instructive cases are to be noted among the species charted, which appear to be intelligible only by reference to temperature conditions. We refer to the two actinians, *Alcyonium carneum* and *Astrangia danæ*. The former was found to be confined to the western end of Vineyard Sound and the extreme lower end of Buzzards Bay. It was not surprising, therefore, to meet with this species at several of the Crab Ledge stations. The case is quite comparable with that of the sponge, *Polymastia robusta*, referred to on page 94, and with many others which will be considered later. The limits of distribution for this species, so far as known, are: Rhode Island

[a] These supplementary dredgings, however, added several species to the fauna of the Bay, so far as recorded by us. These were *Clytia cylindrica*, *Pennaria tiarella* (which is doubtless common enough in shallow waters near shore), *Podocoryne carnea;* and *Schizotricha tenella*. While none of these were taken with sufficient frequency to affect seriously our conception of the cœlenterate fauna of the Bay, they point to the probability of considerable gaps in our original records for this group.

(Verrill) to the Gulf of St. Lawrence (Whiteaves). It is thus predominantly a northern form, which here approaches the southern limit of its range. Temperature is, with little doubt, the determining factor in the distribution of this species in local waters.

What appears to be a type of distribution exactly converse to the last is to be found in the case of the simple coral, *Astrangia danæ*. This species is abundant and of very general distribution throughout most of Buzzards Bay and Vineyard Sound. Indeed, it seems to be almost equally at home upon every sort of bottom, including soft black mud. Now, it will be seen that this form is conspicuously scarce at the open end of Vineyard Sound, i. e., in those same colder waters to which *Alcyonium* seems adapted to live. *Astrangia*, we learn, is a southern species, finding its northward limit at or near Cape Cod, so that its scarcity in the colder waters of the region[a] is thus perhaps explained. It may be suggested, on the other hand, that this gap in the local distribution of *Astrangia* may result from the character of the bottom, which is almost wholly sandy throughout the area in question. The species has, however, been dredged elsewhere upon bottoms of practically pure sand, so that this explanation does not seem sufficient.

If we seek for comparisons between the distributions of different members of the same genus, we find that our dredging records furnish few data of importance upon this subject. *Tubularia couthouyi* and *T. crocea* are seen to present certain characteristic differences, in that the former is largely restricted to stony bottoms, while the latter is of much more general occurrence upon the local sea floor and is abundant, likewise, even upon piles, etc., in shallow water. The former species has not been taken with living hydranths during the summer months, except at Crab Ledge and in the deeper waters south of Marthas Vineyard, while *T. crocea* has been found within the region in an active condition throughout the summer.

Referring to the two commoner species of *Eudendrium* (*E. ramosum* and *E. dispar*), it would seem probable that the distribution of the latter in local waters is far more restricted than that of the former. Indeed, our records point to the scarcity or absence of this species in Buzzards Bay,[b] a condition which affords an interesting contrast to that of *E. ramosum*, one of the few hydroids which were dredged with any frequency in the latter body of water.

Even more striking differences of habitat shown by closely related species of cœlenterates might be chosen among genera which do not figure in our dredging records at all, e. g., *Edwardsia* and *Sagartia*.

The following is a list of the species taken in the course of the Survey dredging. As usual, those species are designated by an asterisk which were taken at 10 or more of the stations:

HYDROZOA.

Ectopleura prolifica.
*Pennaria tiarella (chart 14).
Podocoryne carnea.
*Hydractinia echinata (chart 15).
*Eudendrium ramosum (chart 16).
*Eudendrium dispar (chart 17).
Eudendrium carneum.
Eudendrium capillare.
Eudendrium album.
*Tubularia couthouyi (chart 18).
?Tubularia spectabilis.
Tubularia tenella.

[a] It was not found by us at Crab Ledge.

[b] In the course of the 29 supplementary dredge hauls in Buzzards Bay in 1909, *E. ramosum* was taken eight times, but *E. dispar* was not noted once.

Tubularia crocea (chart 19).
Clytia cylindrica. .
Campanularia verticillata.
Obelia commisuralis.
*Obelia geniculata (chart 20).
Hebella sp. undet.
Keratosum complexum.
Lovenella grandis.
Opercularella pumila.
Calycella syringa.
*Halecium halecinum (chart 21).
Sertularia pumila.
*Thuiaria argentea (chart 22).
Thuiaria cupressina.
Sertularella gayi.
Sertularella tricuspidata.
Hydrallmania falcata.
*Schizotricha tenella (chart 23).

ACTINOZOA.

*Alcyonium carneum (chart 24).
?Pterogorgia gracilis (one small dead fragment).
*Metridium dianthus (chart 25).
Tealia crassicornis.
*Astrangia danæ (chart 26).

If we consider, with respect to their known ranges upon our coast, these 13 species of cœlenterates which were of most frequent occurrence in our dredge hauls, we may group them as follows:

Predominantly northern.

Hydractinia echinata.....Greenland (Mörch) to Charleston, S. C. (McCready).
Eudendrium dispar.....Bay of Fundy to Vineyard Sound (Verrill).
Halecium halecinum.....Gulf of St. Lawrence (Whiteaves) to Long Island Sound (Hargitt).
Thuiaria argentea.....North Polar regions to Maryland (Nutting).
Alcyonium carneum.....Gulf of St. Lawrence (Whiteaves) to Rhode Island (Verrill).
Metridium dianthus.....Labrador to New Jersey (Verrill).

Predominantly southern.

Pennaria tiarella.....Maine to West Indies (Mayer).
Schizotricha tenella.....Marthas Vineyard (Nutting) to Beaufort, N. C. (Fraser).
Astrangia danæ.....Cape Cod to Florida (Verrill).

Having range of approximately equal extent north and south.

Eudendrium ramosum.....Labrador (Verrill) to Bermuda and Beaufort, N. C. (Hargitt).
Obelia geniculata.....On our coast recorded from Labrador (Verrill) to Beaufort, N. C. (Fraser). [Cosmopolitan, according to Mayer.]

Range of doubtful extent.

Tubularia couthouyi.....Probably predominantly northern.
Tubularia crocea.....Casco Bay (Hargitt) to Brooklyn, N. Y. (Verrill), and perhaps to Charleston, S. C.

Thus six of these species appear to be predominantly northern in their range, while only three are known to have a range which is predominantly southern. This is a condition different from that shown by the local representatives of most of the phyla of animals, which as a rule show a decidedly southern bias. We do not believe, however, that this difference has any special significance, particularly since the proportion of our cœlenterates which are common to Canadian waters is no greater than that for the fauna at large.

With the exception of the two cases discussed above (*Alcyonium* and *Astrangia*), none of these species appears to be distributed in relation to temperature in local waters.

In the foregoing calculation we are of course only considering a few of the commonest bottom-dwelling species. Were we to include the multitude of pelagic forms (Medusæ), many of which are stragglers borne hither by the Gulf Stream, it is probable that the ratio of northern to southern forms would be quite different.

4. PLATYHELMINTHES, NEMATHELMINTHES, ETC.

The various classes of "flat worms" are represented in our check list as follows: Turbellaria, 40(+1?); Trematoda, 52(+4?); Cestoda, 71(+3?); Nemertinea, 25 (1?). Of the "round worms" there are 14 Acanthocephala and 21(+5?) Nematodes. The anomalous group of Chætognatha is represented by a single determined species of *Sagitta*, though there may be one or more undetermined members of the genus in local waters. The Dinophilea, which are included in the present section only for the sake of convenience, appear to be represented by at least three species, none of which, however, has been observed during the Survey dredgings.

Except for a comparatively small number of nemerteans (6 species), no representatives of these groups of "worms" appear in the dredging records. Certain nemerteans are abundant locally in the shallow waters near shore, where they live under stones or burrow in the mud or sand; while Turbellaria of a considerable number of species are likewise common in shallow weedy waters. From the fragmentary condition of all the nemerteans which were dredged by us it is evident that the apparatus employed was ill-adapted to unearthing deeply burrowing worms such as these. It is likely, therefore, that our scanty records give a very imperfect idea of the distribution of these species throughout the area dredged.

It was accordingly inevitable that the greater part of our data respecting these groups of organisms should be derived from previously published statements. The records for the Turbellaria and Nemertinea are based chiefly upon the works of Verrill and of Coe, supplemented, in the case of the latter group, by our own dredging records and by a set of manuscript notes kindly furnished by Prof. Coe.[a] The records for the endoparasitic worms (trematodes, cestodes, nematodes, and Acanthocephala) are based for the most part upon the works of Prof. Edwin Linton, who for many years has studied our local fish parasites on behalf of the Bureau of Fisheries. To these published sources of information we must add, however, some valuable unpublished notes, kindly put at our disposal by Dr. Linton.

Acknowledgments for the revision of those portions of the checklist which include these groups are due Prof. Linton and Prof. Coe. To Dr. Coe we are likewise indebted for the identification of the nemerteans taken during the Survey dredging. We have thought it expedient to follow Dr. Linton in retaining provisionally in their earlier sense certain of the genera (e. g., *Distomum*), which have been greatly subdivided by some recent writers. In his own published works, Dr. Linton has taken occasion fully to acknowledge the invaluable assistance of Mr. Vinal N. Edwards, who collected a large part of the material described by him.

Of the 41 Turbellaria comprised in our catalogue, 9 were listed by Verrill in the report of 1873, though only 2 of these were recorded specifically for points within the limits of our region. The records for most of the other species have been derived from Prof. Verrill's later writings and from the recent report of von Graff.

The number of Turbellaria which have been listed from Plymouth, England, is about fifty per cent greater than that contained in our catalogue, and so far as is apparent only two of the species are common to the two regions. Herdman's list for the Irish Sea contains 27 members of this group.

[a] The additional records for Turbellaria contained in the important paper of von Graff (1911) have also been incorporated during the revision of the present report.

Of the 26 nemerteans of our catalogue, 7 appear to be common to the Canadian list and 5 to that of the Plymouth station. The former list comprises 20(+1?) species, the latter 35. Herdman has listed 24(+2?) species for the Irish Sea. None of the groups of parasitic worms appear to have been catalogued at any of these other stations.

Under the circumstances which we have stated, it is natural that few generalized statements can be made regarding the distribution of these groups locally. The parasites were of course taken from the fishes, and it would therefore be futile in most cases to state specific localities for these. Only such species have been listed, however, as are believed to have been taken from fishes captured in strictly local waters.

Regarding the nemerteans, it may be said that in 18 out of the 21 occasions upon which these worms appear in the dredging lists they were taken in Buzzards Bay. It is quite possible, however, that these forms are much more abundant throughout Vineyard Sound than would be implied by these records. As is well known, many of the species burrow rather deeply into the shores and bottoms which they frequent, and considerable digging is often necessary in order to unearth them. Now, the soft bottoms of Buzzards Bay were doubtless, as a rule, penetrated more deeply by the dredge than were the sandy or gravelly bottoms of Vineyard Sound.

Of the six determined species of nemerteans recorded for the Survey dredgings not one was taken with sufficient frequency to warrant our plotting a distribution chart. The species of most frequent occurrence was *Cerebratulus luridus*, which was recorded 10 times, though some of these records are regarded as doubtful. This species was taken throughout the lower half of Buzzards Bay.

The six species recorded by us from our dredgings are:

Lineus bicolor.
Micrura leidyi.
Cerebratulus lacteus.
Cerebratulus marginatus.
Cerebratulus luridus.
Amphiporus ochraceus.

5. BRYOZOA.

Of the Bryozoa, 76(+5?) determined species are recorded for the Woods Hole region of which 5 are Endoprocta, the remainder belonging to the Ectoprocta. These species are assigned to 21 families and 36(+1?) genera. Out of the total number of species recorded, 67 (+1?), or about 85 per cent, were taken during our own dredging operations; some 6 or 7 more were collected by other means during the progress of the Survey, while 5 or 6 others are included wholly upon the authority of published statements.

Several new species have been encountered during the Survey dredging, descriptions of which have been prepared by Dr. Osburn; while about 45 species have been added by us to the known fauna of the region. This latter number is considerably greater than we have been able to record for any other group of organisms, a fact which should not surprise us when we recall that no systematic study of the Bryozoa had been made in these waters within the past 30 years. Indeed, the subject has remained until recently in the same incomplete and rather chaotic condition in which it was left by Verrill. One of the authors of the present report was led to undertake the determination of the species collected during the Survey dredging. This was found to necessitate a critical examination of the literature of the group and a comprehensive study of the bryozoan fauna of our Atlantic coast, the results of which have recently been published.[a]

[a] Osburn, Raymond C.: Bryozoa of the Woods Hole region. Bulletin U. S. Bureau of Fisheries, vol. XXX, 1910 (1912), p. 203–266, pl. XVIII–XXXI.

Desor, in 1848, described two species of Bryozoa (*Bugula turrita* and *Membranipora tenuis*) which were collected by him in the vicinity of Nantucket.

Verrill, in the report upon the invertebrates of Vineyard Sound, listed 33 species of Bryozoa, of which 27 determined species and several doubtful ones were recorded for specified points within the limits of the Woods Hole region. Only one of our local species was there described for the first time. In subsequent papers Verrill added a considerable number of new Bryozoa to the fauna of the deeper waters off the American coast, but not more than 5 of these last fall within the limits embraced by the present report. Nickerson (1898) added a single species of endoproct (*Loxosoma davenporti*) to our local fauna, this being first described from specimens taken by him at Cotuit Harbor. So far as we know this is the only addition which has been made to Verrill's lists of Bryozoa down to the time of the present Survey.

Whiteaves catalogues 115 species of Bryozoa for the waters of eastern Canada. Of these species, 45 (+2?), or about 40 per cent, have been recorded from the Woods Hole region. On the other hand, these 47 species which are common to the two lists constitute nearly 60 per cent of the number comprised in our own catalogue.

The Plymouth list records the occurrence of 103(+1?) members of this group, a number which is also considerably in excess of that recorded for the Woods Hole region. About 30 per cent of the Plymouth species (about 40 per cent, therefore, of the Woods Hole species) are common to the two lists.

Herdman catalogues 136 species of Bryozoa (along with many varieties) for the Irish Sea; while Graeffe has recorded 56 species for the Gulf of Triest.

It is scarcely likely that these figures give us any accurate idea of the relative representation of this phylum in the respective areas of sea bottom. It is not at all probable that the search for these organisms has been equally exhaustive at the various points named, and it is certain that the areas explored are far from being comparable in magnitude (see p. 87). We may assert in full confidence that the extension of our own dredging operations to the 50-fathom line would have very greatly increased our list of Bryozoa.

The average number of species per dredge haul recorded for the stations of the regular series was 2.9. The species having the most general distribution was *Bugula turrita*, which was present at 255 (more than half) of the dredging stations. Those which were encountered so frequently as to be taken at one-fourth or more of the total number of stations are:

Bugula turrita (255 stations).
Crisia eburnea (201 stations).
Schizoporella unicornis (197 stations).
Smittia trispinosa nitida (163 stations).

Representatives of this group are to be found attached to almost every sort of solid object within the waters of our region. Upon stones and shells they form calcareous incrustations, which may be white, gray, yellow, or red in color, and are often many layers in thickness. Such are *Smittia trispinosa nitida* and various species of *Schizoporella*, *Membranipora*, and *Lepralia*.

Other calcareous forms (*Cellepora americana*, *Schizoporella unicornis*, and *S. biaperta*) give rise to coral-like nodules or foliaceous expansions upon Hydrozoa, algæ, or other Bryozoa. Erect, hydroid-like colonies, such as those of *Bugula*, *Bicellaria*, or *Crisia*,

attach themselves to various other fixed organisms, or directly to piles or stones. *Flustrella hispida* forms a thick matting over the rockweed along shore, and several species may be found upon active living animals, such as crabs. One, indeed, makes its home in the gill chamber of the blue crab (*Callinectes sapidus*). Various minute Bryozoa may readily be mistaken for hydroids, or may be overlooked altogether. Thus there is little doubt that many such forms escaped the collectors entirely during the earlier dredging work of the survey. With some few exceptions, the incrusting species are the ones which figure most prominently in the dredging records, colonies of this sort seldom being absent from stones or shells. Owing to the superficial similarity of several quite distinct species of incrusting Bryozoa, it was our practice throughout the dredging work to save for preservation samples of even the commonest species from every dredge haul in which they occurred. Only three species of Bryozoa (*Bugula turrita*, *Crisia eburnea*, and *Cellepora americana*) were regularly identified by the collectors in the field, and there seems to be little probability that these were confused with any less familiar forms. All other species, so far as detected, were preserved for future examination. These were later identified by Dr. Osburn, who is likewise responsible for the classification here adopted.

Charts (27–46) have been prepared showing the distribution of those species which were recorded from 10 or more of the dredging stations.[a] Two of these species, *Lepralia americana* and *L. pallasiana*, were confused in the earlier dredging records to such an extent that it has been thought best to plot their combined distributions upon a single chart. Thus there are only 20 charts for these 21 species.

Less of general interest is to be gathered from the local distribution of the Bryozoa than from that of many other groups which we have considered. Only two distinct types of distribution are to be found among those forms which have been dredged with any frequency in local waters. We have (1) species whose distribution is general, or without any definite restrictions throughout Vineyard Sound and Buzzards Bay; and (2) species found wholly, or at least predominantly, in Vineyard Sound. Not a single species has been found which appears to be restricted in any degree to the Bay. Thus the phylum has a considerably greater representation in the Sound than in the Bay. The average number of species taken per dredge haul[b] may be tabulated as follows:

Vineyard Sound:	
Fish Hawk stations	3.4
Phalarope stations	3.0
Buzzards Bay:	
Fish Hawk stations	2.7
Phalarope stations	2.0

The average number of species for the Crab Ledge stations would doubtless greatly exceed any of these figures, but unfortunately the data are not available.

It is highly probable that the character of the bottom has been the chief factor in determining the results here tabulated, just as in the case of the Hydrozoa. Reference to the table on page 79 shows that the average number of species per dredge haul for

[a] Including the supplementary stations of 1906–1909, for the same reason as already stated in the case of the Foraminifera and cœlenterates.

[b] Based upon the original stations only. Were the supplementary dredgings to be considered in this computation, it is likely that the figures for Buzzards Bay would be somewhat greater, though it is quite improbable that they would equal those for Vineyard Sound.

gravelly and stony bottoms is 3.7, that for sandy bottoms being 2.8, and that for muddy bottoms being 2.0.

The same fact is shown by an enumeration of those species which were taken at one-half or more of the dredging stations on each type of bottom. Four species (*Crisia eburnea, Bugula turrita, Schizoporella unicornis*, and *Smittia trispinosa nitida*) are recorded as present in more than half of the dredge hauls made upon gravelly or stony bottoms; a single species (*Bugula turrita*) is listed for as great a proportion of the dredge hauls upon sandy bottoms; while not a single species was found with sufficient frequency upon muddy bottoms to appear in this list.[a]

It is obvious, however, that no such bare characterization of the type of bottom properly describes the habitat of a fixed organism which depends for support upon the presence of some solid substratum. Now various solid objects, organic and inorganic, are commonly present, even upon bottoms of practically pure sand, and such objects frequently furnish attachment for Bryozoa. Even soft mud commonly contains dead shells or fragments of these, and some typical fixed organisms, such as the coral *Astrangia* and the serpulid worm, *Hydroides*, are consequently of frequent occurrence upon muddy bottoms. We believe, nevertheless, that the comparative paucity of Bryozoa upon such bottoms is due in part to the scarcity of suitable objects for attachment. Thus the relative infrequency of *Cellepora americana* and *Hippothoa hyalina* in Buzzards Bay is probably correlated with the scarcity of hydroids and algæ. On the other hand, it seems probable that the continued deposition of silt is unfavorable to the growth of many forms, even though a suitable basis of support be present.

Grouping those species which have been charted by us, according to whether their distribution is general or restricted, we may arrange them provisionally under two heads. In making this classification, the greater absolute number of dredging stations in Vineyard Sound must be taken into account.

Species having a general or unrestricted distribution in local waters.

Crisia eburnea.
Æ̈tea anguina.
Bugula turrita.
?Membranipora pilosa.
Membranipora aurita.
Schizoporella unicornis.
Schizoporella biaperta.
Lepralia americana+pallasiana.
Lepralia pertusa.
Smittia trispinosa nitida.
Hippuraria armata.

Thus the majority of our commoner species do not appear to show any marked preference for one or the other body of water. One of the foregoing species (*Membranipora pilosa*) appears, however, to display an avoidance of the more central regions of the Bay. In the above list it will be seen that both erect and incrusting forms are included.

Species restricted wholly or mainly to Vineyard Sound.

	Number of stations.
Bicellaria ciliata	16 Sound+ 3 Bay.
Membranipora tenuis	59 Sound+17 Bay.
Membranipora flemingii	12 Sound+ 0 Bay.
Cribrilina punctata	12 Sound+ 0 Bay.
Hippothoa hyalina	26 Sound+ 7 Bay.
Cellepora americana	66 Sound+13 Bay.

[a] It must be added, however, that the lists (pp. 70, 71 above) of species present in *one-fourth* or more of the dredge hauls upon these respective types of bottom comprise about equal numbers of Bryozoa.

At least two of the foregoing species (*Membranipora tenuis* and *Hippothoa hyalina*), while occurring with some frequency in the Bay, are restricted for the most part to the neighborhood of land.

The preponderance of some of these forms in the Vineyard Sound records is probably due in part to the relative imperfection of our data for Bryozoa from Buzzards Bay. Supplementary dredgings in the Bay, during the summer of 1909, revealed the presence of a number of species not hitherto found there, and indicated that certain others were not so scarce in this body of water as had been supposed. Indeed, it has been necessary to remove certain species from this second list which had earlier been placed there. Concerning the following species it is not believed that we have sufficient data to warrant any conclusions as to their relative abundance in the Bay and the Sound:

Tubulipora liliacea.
Membranipora monostachys.
Bowerbankia gracilis.

As a matter of fact all three of these species are recorded from an absolutely greater number of stations in the Sound than in the Bay. One of them (*Membranipora monostachys*) has been recorded in the latter only from the stations near land.

Aside from the few cases mentioned, in which the occurrence of certain species in the Bay is limited to the inshore waters, there is nothing in the distribution of any of the species, so far as shown by the charts, which can be regarded as in any sense "bathymetric." Certain species which do not appear in our distribution charts, however, are restricted to shallow waters, or to the immediate neighborhood of land, and indeed may find their proper habitat in the littoral or intertidal zone. The most familiar instance of the last sort is the abundant *Flustrella hispida*, which occurs in great profusion upon the rockweeds, *Fucus* and *Ascophyllum*. Certain other species, likewise, such as *Eucratea chelata*, *Amathia dichotoma*, and *Bugula flabellata*, have seldom been encountered by us except upon piles. Another species, *Membranipora tehuelcha*, has only been noted upon the floating gulfweed, with which it is borne passively to our waters. This, like so many other species having the same habitat, is a southern form which does not properly belong to our local fauna.

Not a single instance has been found among our dredging records of a species of this group whose distribution in Vineyard Sound and Buzzards Bay appears to be determined by temperature. There dwell, however, within the outlying colder waters of the region considered by us, a considerable number of species, most of which represent a strictly northern fauna, and many of which, indeed, find in Woods Hole or vicinity their southern limit of distribution. A number of these have not previously been recorded south of Canada. A list of those species is presented, herewith, which have been taken by us at Crab Ledge or in the vicinity of Nantucket, but not within Vineyard Sound or Buzzards Bay. Data are included respecting their distribution as heretofore known.

Crisia cribraria.....Canada.
Stomatopora diastoporoides ....British Isles, Baffins Bay, Gulf of St. Lawrence.
Tubulipora atlantica.....North Atlantic from Labrador to Florida; Australia.
Tubulipora flabellaris.....Northern Atlantic and Arctic seas; Greenland, Gulf of St. Lawrence, Grand Manan; Mediterranean?
Gemellaria loricata.....Northern Atlantic and Arctic seas; Labrador, St. Georges Banks, Grand Manan.

Scruparia clavata.....British Isles, Gulf of St. Lawrence.
Cellularia peachii.....Northern Atlantic and Arctic seas; Labrador, Gulf of St. Lawrence, St. Georges Banks.
Menipea ternata.....Northern Atlantic and Arctic seas; Labrador, Gulf of St. Lawrence, Grand Manan.
Caberia ellisii.....Northern Atlantic and Arctic seas; Greenland, Labrador, Gulf of St. Lawrence, Maine.
Bugula cucullifera .....Maine; off Cape Cod.
Bugula murrayana.....Northern Atlantic and Arctic seas; Greenland, Labrador, Gulf of St. Lawrence, New England.
Membranipora cymbæformis....Northern Atlantic and Arctic seas; Gulf of St. Lawrence.
Membranipora craticula.....Northern Atlantic and Arctic seas; Davis Strait, Gulf of St. Lawrence.
Membranipora unicornis.....Northern Atlantic and Arctic seas; Greenland, Gulf of St. Lawrence, North Pacific.
Membranipora arctica.....
Cribrilina annulata....."Eminently a northern form;" Spitzbergen, Greenland, Labrador, Gulf of St. Lawrence, Grand Manan.
Porina tubulosa.....Northern Atlantic and Arctic seas; Gulf of St. Lawrence.
Schizoporella auriculata.....Red and Mediterranean Seas to Arctic Ocean; Gulf of St. Lawrence.
Schizoporella sinuosa.....Northern Atlantic and Arctic seas; Gulf of St. Lawrence.
Cellepora canaliculata.....Gulf of St. Lawrence; off Halifax.
Mucronella pavonella.....Northern Atlantic and Arctic seas; Gulf of St Lawrence, North Pacific.
Smittia porifera .....North Atlantic and Arctic seas; Gulf of St. Lawrence, Florida, South Africa, Australia.
Porella propinqua.....Northern Atlantic and Arctic seas; Gulf of St. Lawrence, Davis Strait.
Porella acutirostris.....Northern Atlantic and Arctic seas; Gulf of St. Lawrence.
Porella concinna.....Arctic seas to Mediterranean; Greenland, Gulf of St. Lawrence.
Rhamphostomella costata.....Northern Atlantic and Arctic seas; Gulf of St. Lawrence.
Alcyonidium parasiticum .....British Isles.

The following notes have been furnished by Dr. Osburn relative to differences of habitat displayed by different members of the same genus:

Crisia.

C. eburnea: Our most familiar species; abundant in shallow waters, but extending to the deepest waters of the region.

C. cribraria: Found only in the outside, colder waters.

Bugula.

B. turrita: Abundant under all conditions in the inner waters; less common in the cold waters off shore, e. g., at Crab Ledge.

B. flabellata: On piles and in shallower waters down to a few fathoms; almost wholly confined to adlittoral zone.

B. murrayana: Abundant in outer waters on stones and shells; not found in inner waters.

Membranipora.

M. cymbæformis: Common upon hydroid and other stems in outside waters.

M. pilosa: Common throughout our waters on shells and algæ; differing in the form of the zooecia, according to substratum occupied.

M. unicornis: On stones and shells in outer waters.

M. monostachys: Throughout our waters; common, usually upon very smooth surfaces, such as inside of shells, on skate eggs, carapace of Limulus, etc. It presents differences of form, according to whether it grows in inner or outer waters.

M. tenuis: Common upon stones and shells, but not in shallow waters near shore.

M. flemingii: (Much as last).

M. aurita: Common on stones, shells, and algæ, at all depths.

M. tehuelcha: Only found upon drifting gulfweed.

Cribrilina.
C. punctata: Common in Vineyard Sound and outer waters, on stones and shells.
C. annulata: Only in outer, colder waters.
Schizoporella.
S. unicornis: Everywhere, forming massive colonies; less frequent in outside waters.
S. biaperta: Throughout our waters, forming flat colonies on stones and shells, or (more frequently) forming fanlike expansions on algæ, etc.
S. auriculata: Only in outside waters.
S. sinuosa: Only in outside waters.
Hippothoa.
H. hyalina: Of general distribution on algæ, shells, stones, etc.; best developed on stems of algæ and hydroids, where it forms nodular crusts.
H. divaricata: Locally, not at all common and found only in the outer waters, though not elsewhere restricted by temperature.
Lepralia.
L. americana: Throughout our waters on stones and shells, especially in deeper waters.
L. pallasiana: On stones, shells, piles, and eel grass; of general occurrence, but more frequent in shallow waters.
L. pertusa: Of general distribution; most common on shells and pebbles.
Mucronella.
M. peachii: Occasional in Sound and in outside waters, forming flat crusts on stones and shells.
M. pavonella: In outside waters only, forming flat colonies upon stones and shells, or rising into fanlike expansions on stems of hydroids, etc.
Smittia.
S. trispinosa nitida: Of very general occurrence, growing upon all sorts of objects, and forming massive nodular crusts on stones and shells.
S. porifera: In outer waters, on stones and shells; smaller colonies sometimes taken in inner waters.
Cellepora.
C. americana: Of general distribution on stems of hydroids or algæ, forming nodules or irregular masses.
C. canaliculata: In outside waters, forming rounded, pisiform colonies on stems of hydroids, etc.
Alcyonidium.
A. verrilli: Western end of Vineyard Sound; erect and branching.
A. parasiticum: In outside waters, incrusting stems and stones; argillaceous matter combined in zoarium.
A. mytili: In various situations in inside waters, incrusting, not argillaceous.
Bowerbankia.
B. gracilis and its variety caudata: Creeping over stems of other organisms, or upon piles; occurring together.
Hippuraria.
H. armata: Of general occurrence; creeping upon stems, etc., or erect.
H. elongata: Commensal in branchial chamber or on carapace of crustacea.

The following list comprises the Bryozoa collected by us in the course of the Survey dredging. A considerable number of these species were not taken, however, at any of the regular (numbered) stations, and a good many have been recorded only from outlying points, such as Crab Ledge or the shoals to the east of Nantucket. Those species which were taken at 10 or more of the stations in Vineyard Sound and Buzzards Bay are, as usual, designated by an asterisk.

Pedicellina cernua.
Barentsia major.
Barentsia discreta.
*Crisia eburnea (chart 27).
Crisia cribraria.
*Tubulipora liliacea (chart 28).
Tubulipora atlantica.
Tubulipora flabellaris.
Stomatopora diastoporoides.
Lichenopora verrucaria.

*Ætea anguina (chart 29).
Gemellaria loricata.
Scruparia clavata.
Cellularia peachii.
Menipea ternata.
Scrupocellaria scabra.
Caberea ellisii.
*Bicellaria ciliata (chart 30).
*Bugula turrita (chart 31).
Bugula gracilis uncinata.
Bugula cucullifera.
Bugula flabellata.
Bugula murrayana.
Membranipora cymbæformis.
*Membranipora pilosa (chart 32).
Membranipora craticula.
Membranipora lineata.
Membranipora unicornis.
*Membranipora monostachys (chart 33).
*Membranipora tenuis (chart 34).
*Membranipora flemingii (chart 35).
*Membranipora aurita (chart 36).
Membranipora arctica.
Membranipora arctica armifera.
*Cribrilina punctata (chart 37).
Cribrilina annulata.
Porina tubulosa.
Microporella ciliata.
Microporella ciliata stellata.
*Schizoporella unicornis (chart 38).
*Schizoporella biaperta (chart 39).
Schizoporella auriculata.
Schizoporella sinuosa.
*Hippothoa hyalina (chart 40).
Hippothoa divaricata.
*Cellepora americana (chart 41).
Cellepora canaliculata.
*Lepralia americana (chart 42).
*Lepralia pallasiana (chart 42).
*Lepralia pertusa (chart 43).
Lepralia serrata.
Mucronella ventricosa.
Mucronella peachii.
Mucronella pavonella.
Smittia trispinosa.
*Smittia trispinosa nitida (chart 44).
Smittia porifera.
Porella propinqua.
Porella acutirostris.
Porella concinna.
Porella proboscidea.
Rhamphostomella bilaminata.
Rhamphostomella costata.
Rhamphostomella ovata.
Alcyonidium verrilli.
Alcyonidium parasiticum.
Alcyonidium mytili.
*Bowerbankia gracilis (chart 45).
Bowerbankia gracilis caudata.
Anguinella palmata.
*Hippuraria armata (chart 46).

Referring to the 21 commoner species, it has not been found possible to distinguish the majority of them, according to their range, as predominantly northern or southern. This results partly from the fact that so many of the Bryozoa are surprisingly cosmopolitan in their distribution, partly from the fact that our knowledge of their distribution in American waters is so meager. In a considerable number of instances it would appear from the few American records at our disposal that a species was predominantly northern or southern in its distribution, when reference to foreign records shows that such is not the case. Even those few species which we have here distinguished as predominantly northward or southward ranging are so designated in a purely tentative way.

Predominantly northern.

Tubulipora liliacea.....Labrador to Long Island Sound.
Bicellaria ciliata.....Northward on our coast to the Gulf of St. Lawrence.
Membranipora flemingii.....Greenland to Vineyard Sound (recorded from Adriatic).
Cribrilina punctata.....Northward on our coast to Gulf of St. Lawrence.

Predominantly southern.

Bugula turrita.....Casco Bay to Florida.
Membranipora monostachys....Nantucket Sound to Beaufort, N. C.
Membranipora tenuis.....Same as last.
Hippuraria armata.....Same as last.

Three of the four last named species are ones which have only been listed from American waters.

Of very wide range in both directions.

Crisia eburnea.....Labrador to Florida (cosmopolitan).
Ætea anguina.....Cosmopolitan; upon our coast recorded from points as far south as Beaufort, N. C.
Membranipora pilosa.....Greenland to Beaufort, N. C. (cosmopolitan).
Schizoporella unicornis.....Greenland to Florida (Europe and Africa).
Schizoporella biaperta.....Greenland to Florida (Spitzbergen, Algiers, etc.).
Hippothoa hyalina.....Greenland to Florida (cosmopolitan).
Lepralia pertusa.....Greenland to Florida (cosmopolitan).

Position doubtful, owing to insufficiency of data.

Membranipora aurita.....Not previously recorded from America.
Cellepora americana.....(?)
Lepralia pallasiana.....Perhaps northern.
Lepralia americana.....Known only from a small section of our coast.
Smittia trispinosa nitida.....Known from only a small section of our coast (also Australia).
Bowerbankia gracilis caudata..Known only from a small section of our coast.

Thus a considerable majority of these species have either an almost unrestricted range in latitude, or a range of doubtful extent. Four have been classified as predominantly northern and an equal number as predominantly southern. If, however, our calculations had been based upon the entire list of local Bryozoa, including the many species (p. 106, 107) which were listed only from outlying points, we should have been led to regard our bryozoan fauna as being, on the whole, preponderatingly northern in its character.

6. ECHINODERMATA.

This phylum is represented in local waters by only 24(+1?) known species. Of these, 6 belong to the Asteroidea, 6 to the Ophiuroidea, 4 to the Echinoidea, and 8 (+1?) to the Holothuroidea. Eighteen of these species appear in the dredging records of the Survey, as follows: Asteroidea, 6; Ophiuroidea, 5; Echinoidea, 3; Holothuroidea, 4. Data relating to several other species have, however, been furnished by various of our Woods Hole collectors. The other records for local echinoderms are based mainly upon the published statements of Verrill and of H. L. Clark. In the classification adopted by us we have followed Dr. Clark. To this authority we are indebted for the identification of many specimens, as well as for the criticism of those portions of our manuscript which relate to the Echinodermata.

Verrill and Smith (1873) listed 19 species of echinoderms for Vineyard Sound and adjacent waters. Among these were comprised 5 species belonging to the Asteroidea,[a] 4 to the Ophiuroidea, 4 to the Echinoidea, and 6 to the Holothuroidea. To these must be added 1 holothurian (*Molpadia oolitica*), which was included doubtfully, and 1 ophiuran (*Amphiura abdita*), which was reported by Verrill only from Long Island Sound, but which has since been found in Vineyard Sound and Buzzards Bay. Disregarding the holothurian just mentioned, all of the species listed by Verrill for these waters have been taken by subsequent collectors.

Except in one questionable case, our dredging operations have added no species to the known fauna of the region. This exception is the brittle star just referred

[a] One of these, it is true ("*Asterias arenicola* Stimpson"), is not now regarded as a distinct species, but is, as Verrill himself thought likely, identical with *A. forbesi*. The name "green starfish," by which Verrill repeatedly refers to this species, is certainly a misnomer, so far as our local specimens are concerned.

to (*Amphioplus abdita* (Verrill)), which was taken at about the same time by Mr. G. M. Gray and by our own collectors on the *Fish Hawk*, and has since been dredged by us on several occasions.[a] It appears, indeed, that this species is not uncommon in local waters, and the same has proved to be true of the holothurian *Caudina arenata*, which was previously regarded as very rare locally.

Reference to the comparative table on page 88 shows that the phylum of Echinodermata is very poorly represented in the Woods Hole region, as compared with each of the other localities which have been considered. For the phylum as a whole we have the following figures: Woods Hole, 24(+1?); Eastern Canada, 71; Plymouth, 36; Irish Sea, 35; Triest, 37.

In the case of the Asteroidea and Ophiuroidea in particular, these figures are uniformly higher for the other stations than for Woods Hole. Again, our own list is the only one among them which is completely lacking in crinoids, for even *Antedon* has not thus far been met with in our waters.

Fourteen of our 24 echinoderms are common to Whiteaves's list for eastern Canada, while only 2 (perhaps only 1) are common to the Plymouth list.

In making any comparisons between these faunal lists, the usual allowance must be made for the widely different areas to which they relate, as well as to the widely different ranges in depth. Comparisons with Plymouth or with Trieste appear to be much fairer than with either of the other regions, so far as area is concerned.

The average number of species of echinoderms dredged at the 458 regular stations of the Survey was 1.9. The species which was encountered with greatest frequency was *Asterias forbesi*, which was recorded from 206 of the stations. The only ones which were recorded from as many as one-fourth of the total number of stations are:

	Number of stations.
Asterias forbesi	206
Echinarachnius parma	170
Arbacia punctulata	156
Henricia sanguinolenta	118

Owing to the comparatively large size of most members of this phylum, and to the very limited number of species which occur in local waters, it seems likely that our list of echinoderms is particularly complete. If additions are made subsequently, it will probably be among the ophiuroids and the holothurians, some of which are of small size and given to burrowing or to concealment in crevices of stones, etc. It is likely, too, that our dredging records for this group are fairly free from errors of omission or confusion of one species with another. Reference should be made, however, to certain mistakes of identification, which we believe to have been made at first.

(1) It is probable that during the early days of the work the younger specimens of *Asterias vulgaris* and *A. forbesi* were sometimes confused in the field. So far as this confusion may relate to Vineyard Sound, the results can not be serious, since our later and more accurate exploration of the Sound has shown that both species occur throughout practically its entire length. As regards Buzzards Bay, specimens of *Asterias vulgaris* were recorded from five stations within its interior, which it has been decided to leave out of consideration in plotting the distribution chart for this species. The records have,

[a] See Clark, in Science, Jan. 24, 1908, and Sumner, in American Naturalist, May, 1908. According to Dr. Clark, Mr. Gray's specimen was taken in August, 1907 (exact date not stated). Our own first specimen was dredged on Aug. 6, 1907. Here, then, is a most perplexing question of priority!

however, been retained in the list of stations for this starfish, as given in our catalogue, though their doubtful nature has been indicated. Supplementary dredgings were made in Buzzards Bay during two subsequent seasons, partly for the purpose of testing this feature in the distribution of *Asterias vulgaris*. Out of a total of nearly 60 stations, starfishes of this genus were recorded for 11. These were in all cases assignable to *Asterias forbesi*, with the exception of a few small specimens of *A. vulgaris* taken at two stations situated near the island shores and not far from the mouth of the Bay. Accordingly we regard the occurrence of the latter species in the interior portions of Buzzards Bay as being extremely doubtful.

(2) Doubt has been cast upon our earliest field identifications of the ophiuroids. For this reason, it has been regarded as fairer to bring together the records for the first year, except such as are based upon authoritative determinations, under the heading "ophiuroids unidentified." Such specimens were probably in most cases referable to the species *Amphipholis squamata*.

Distribution charts have been plotted for seven species of echinoderms (charts 47 to 53).[a] It will be seen at a glance that only two of these species (*Asterias forbesi* and *Arbacia punctulata*) were encountered with any frequency in Buzzards Bay, while of these two the former alone was generally distributed throughout the central portions of the Bay. *Arbacia* and certain other species (notably *Henricia*) were found to be largely restricted, in Buzzards Bay, to the immediate neighborhood of land. For these facts, as for similar ones already discussed in our treatment of other groups, we believe that the character of the bottom is chiefly responsible. Most of our commoner local echinoderms prefer bottoms of gravel or sand to ones of mud. To this statement, it is true, exceptions are offered by some of the holothurians and ophiuroids.

From the table on page 79 it will be seen that the average number of species of echinoderms per dredge haul, taken upon bottoms of gravel and stones, is 2.2; that for sandy bottoms being 2.0, and that for muddy bottoms being only 1.2. The different classes, however, do not agree in these preferences. The figures both for holothuroidea and ophiuroidea are greatest for muddy bottoms; but, owing to their infrequent occurrence in the dredge hauls, they do not seriously affect these averages.

The relative wealth of the echinoderm fauna upon different types of bottom is shown in another way by an enumeration of the species which were taken in one-fourth or more of the dredge hauls made upon bottoms of each type (p. 70, 71). In the list for sandy bottoms are comprised 2 asteroids and 2 echinoids; in that for gravelly and stony bottoms, 2 asteroids and 1 echinoid; in that for muddy bottoms, a single asteroid and no echinoids. Similarly, 3 asteroids and 2 echinoids appear in the list of species (p. 65) taken at one-fourth or more of the *Fish Hawk* stations in Vineyard Sound, while only 1 asteroid and no echinoids appear in the corresponding list for Buzzards Bay. The lists for the *Phalarope* stations in the two bodies of water do not show as great differences, since the conditions in the "adlittoral" region are more nearly similar throughout, but the preponderance is nevertheless somewhat in favor of Vineyard Sound.

A species which is restricted more than any other to bottoms of pure sand[b] is the "sand dollar," *Echinarachnius parma*. Character of the bottom, rather than tempera-

[a] In the case of the charts for shell-bearing organisms, the occurrence of living specimens at a given station has been indicated by a circle surrounding the star. Among the echinoderms this practice has been followed only in the case of the two sea urchins, *Arbacia* and *Strongylocentrotus*, these being the only ones which would be likely to leave behind enduring remains. It has been assumed for these two that all the field records relate to living specimens unless the contrary is expressly stated.

[b] The dead tests are of more general occurrence, owing probably to the fact that they may be drifted by tidal currents.

ture, is probably responsible for the greater prevalence of this species in the western half of Vineyard Sound, where, as we have pointed out elsewhere, certain typical sand-dwelling species find their most congenial habitat.

On the other hand, certain less frequent species (not among those charted) were dredged chiefly upon muddy bottoms. Particularly worthy of mention is the holothurian *Caudina arenata*, which was taken by us seven times in Buzzards Bay and only once in Vineyard Sound.

The part played by temperature in determining distribution is rather strikingly illustrated by some members of our echinoderm fauna. The local distribution of the two commoner species of *Asterias* is quite in keeping with what we know of the ranges of these two forms upon our coast. A glance at charts 48 and 49 shows us that whereas *Asterias forbesi* has a practically unrestricted distribution in local waters, *A. vulgaris*, on the contrary, is most prevalent in the colder portion of Vineyard Sound. Indeed, there is seen to be a progressive concentration of the distribution symbols as we pass from the eastern to the western end of the Sound, while in the Bay the records are confined to the neighborhood of the open ocean. It is likewise worth noting in this connection that the latter species was recorded from all seven of our regular dredging stations at Crab Ledge, while *Asterias forbesi* was recorded but once.

As stated by Clark, the range of the latter species upon our coast is from "Maine to the Gulf of Mexico," but it is said to be "rare or local north of Cape Ann." It is primarily a shallow water form, which does not appear to pass beyond depths of 25 or 30 fathoms. *A. vulgaris*, on the other hand, ranges from Labrador to Cape Hatteras, though it is "rarely seen in shallow water * * * south of the Woods Hole region." It is recorded from depths as great as 358 fathoms.

Such natural expectations as to distribution in local waters are not, however, realized in the case of another starfish, *Henricia sanguinolenta*. This species, also, is listed as "littoral only as far south as the Woods Hole region," while, to the northward, it extends to Greenland. The dredging records show it to be abundant throughout the length of Vineyard Sound and, indeed, to be rather commoner in the eastern (warmer) half. It is likewise recorded from scattered stations in Buzzards Bay, even well toward its head. For this species, then, temperature seems to be a minor factor in determining the distribution in local waters.

Of considerable interest are the relative distributions of our two local sea urchins, *Arbacia punctulata* and *Strongylocentrotus droebachiensis*. The former species appears to be of general occurrence throughout Vineyard Sound, except for the portion adjoining the open ocean. In Buzzards Bay it occurs as far as the upper end, but it seems here to be restricted largely to the vicinity of land. *Strongylocentrotus*, on the other hand, occurs in greatest abundance in the western portion of Vineyard Sound, though occasional specimens have been taken as far eastward as West Chop. In Buzzards Bay it is found only near the extreme lower end. Again, *Strongylocentrotus* was taken at all seven of the stations at Crab Ledge, while *Arbacia* was not found there once. The latter species occurs locally at all depths, even up to the low-water mark. The former species, on the other hand, is rarely if ever taken at such slight depths, except in northern waters.[a] We have very few records of its occurrence in less than 5 fathoms,

[a] Verrill, it is true, states that this species occurs "at low water on the outer rocky shores." This can not be a common occurrence locally, however.

and in the great majority of cases (72 per cent) it was taken at depths greater than 10 fathoms.[a]

Comparing the range of these two species upon our coast, we find that *Arbacia* is said to occur from "Nantucket Shoals and Woods Hole to west Florida and Yucatan" (Clark), i. e., our region lies at its northern limit of distribution. The range of *Strongylocentrotus*, on the other hand, is said to be "circumpolar; southward in the western Atlantic to New Jersey (not in shallow water south of Cape Cod)."

That *Arbacia* is not adapted to enduring temperatures lower than those generally prevailing in our local waters during the winter months is indicated by the fact that a large proportion of these urchins seem to have been exterminated in Vineyard Sound during the winter of 1903–4. This winter was an extremely severe one, the ice being greater in quantity and lasting longer than for many years previously. Even Woods Hole passage, where the tidal currents are extremely swift, was frozen over so firmly that Mr. Vinal Edwards accomplished the astonishing feat of walking over to Nonamesset Island. Reference to the temperature tables for the Woods Hole station (p. 47) shows that the mean water temperature for January and February, 1904, was 29.3° F., as compared with 32.3°, the mean of these two months for the other four years comprised in the table.

Now the sudden and extreme scarcity of *Arbacia* in Woods Hole Harbor and elsewhere in the summer of 1904 was noted by local collectors generally, and we are informed by the curator of the Marine Biological Laboratory, Mr. George M. Gray, that this species did not for several years resume anything like its former abundance in local waters.[b]

Fortunately we are in possession of definite data on this subject, based upon a comparison of our dredging records for the summers of 1903 and 1904. As has been stated on page 55, a considerable number of the 1903 stations were repeated in the following summer for the sake of comparisons and verifications. In the two parallel columns below we present the records for *Arbacia*, obtained during these two seasons, in that part of the Sound (the eastern two-thirds) in which the stations were duplicated:

1903.	1904.
	7521bis (fragments and spines).
7522 (many living).	7522bis (none).
7523 (several living).	7523bis (1 spine).
7524 (very abundant, living).	7524bis (none).
7526 (2).	
7529 (few).	
7530 (abundant).	7530bis (none).
7531 (1 dead).	7531bis (few fragments).
7532 (many).	7532bis (few spines).
7533 (few, many spines).	7533bis (1 small living).
7534 (numerous).	7534bis (few spines).
7535 (few shells, many spines).	7535bis (many spines).
	7536bis (many spines).
7537 (many, rather small).	7537bis (none).
	7538bis (spines and fragments).
7539 (few).	7539bis (none).
7540 (few).	

[a] This despite the fact that hardly more than a third of our stations were in waters as deep as that.

[b] In 1908 and 1909 we were able to obtain large quantities of these urchins in Vineyard Sound by means of tangles.

1903.	1904.
7541 (few).	7541bis (many spines).
	7542bis (several spines).
7543 (fragment).	7543bis (none).
7545 (numerous living).	7545bis (fragment of shell and many spines).
7546 (few living).	7546bis (spines).
	7547bis (several living and fragments).
7549 (many living).	7549bis (few fragments and spines).
7550 (fragments).	7550bis (few spines).
7551 (few living).	7551bis (1 living, several fragments).
7552 (few).	7552bis (few spines).
	7553bis (few spines).
7554 (1 small dead).	7554bis (none).
7555 (numerous).	
7556 (few).	7556bis (many fragments and spines).
7557 (1 shell).	
7558 (many living).	
7559 (few living).	
7561 (about 2 bushels).	
7562 (few living).	7562bis (none).
7563 (many living).	7563bis (spines and fragments).
7564 (many living).	7564bis (many spines).
7566 (many spines).	
7567 (many spines).	
7568 (many spines).	
	7569bis (spines).

Thus in 1903 the presence of living specimens is expressly recorded in 12 out of 36 stations at which *Arbacia* occurred, and it is certain that they were present at many of the other stations, perhaps in all cases where the contrary is not explicitly stated. Such records as "few," "many," or "2 bushels" certainly refer, for the most part, to living specimens. We may state confidently, therefore, that living sea urchins of this species, sometimes in large numbers, were taken at from one-half to two-thirds of the stations in question. In 1904, on the other hand, living specimens (never in large numbers) were recorded from only 3 of the 23 stations at which *Arbacia* or its remains were taken. In all other cases the records are for spines and fragments.[a] Furthermore, this condition was equally manifest during the succeeding season. Stations 7735 to 7757 (dredged in 1905) cover practically the same region of the Sound as stations 7521 to 7569. At these 23 stations of the later year spines (in one case fragments) are recorded in 12 cases; in not a single case was a living *Arbacia* taken. Reference to the complete station list for this species shows that throughout the Sound as a whole (stations 7678 to 7783) living specimens of *Arbacia* were taken but 5 times during the summer of 1905, and that never more than 2 (in four cases a single one) were taken at one time.[b]

[a] The number of records for spines only would have been somewhat greater, it is true, during the summer of 1903, had the sand, etc., brought up by the dredge, been searched as carefully that year as during subsequent seasons.

[b] It is to be noted in the case of *Strongylotrotus*, likewise, that a large proportion of the later (1905) records (7678 to 7752) indicate the presence of spines and fragments only, while living specimens alone were noted in 1903. This last circumstance was, however, doubtless due in considerable measure to the fact that the loose spines of the green urchin were overlooked during the first season (see preceding footnote). The absolute number of stations from which living specimens are recorded in 1905 (counting as living all those not listed as "fragments" or "spines") was 8, as compared with 10 during the summer of 1903. Moreover, at 4 out of 5 of the "bis" stations (1904) at which this species was taken the records indicate living specimens. Thus it seems unlikely that *Strongylocentrotus* was unfavorably affected during the winter which wrought such havoc with *Arbacia*. The same may be said of the "sand dollar," *Echinarachnius*. We find no evidence of any destruction of this species at that time.

How the severe cold prevalent during the winter under consideration could have resulted in the death of organisms dwelling in several (sometimes many) fathoms of water is difficult to see. With animals so situated an actual freezing seems to be out of question, and the temperature to which they were subjected on this occasion was only a few degrees lower than that ordinarily endured by them in the winter. Furthermore, it must be pointed out that the peculiarities in the local distribution of *Arbacia* correspond to known differences in summer temperatures, not winter temperatures. As has been shown above (p. 50), it is likely that in winter all our waters attain practically the same temperature at the coldest period of the year; and indeed it is the shallower, more inclosed waters, such as those frequented by *Arbacia*, which are the ones to respond most quickly to the winter cold. Further consideration will be given to this subject in chapter V (p. 177).

In addition to these illustrations, which have been discussed at length, we find several other instances among this group of species whose distribution in local waters is certainly related to temperature. Thus *Asterias austera*, *Solaster endeca*, and *Gorgonocephalus agassizii*, which reach their southern limit of distribution in this region, have been taken by us only at Crab Ledge; while *Asterias tenera*, though recorded from points as far south as New Jersey, is predominantly a northern form, and locally is only known from outlying points such as Crab Ledge and Sankaty Head. Again the brittle star *Ophiopholis aculeata* and the peculiar little holothurian *Thyone unisemita*, the first of which, at least, is known to be a predominantly northern form, have only been recorded by us from the western end of Vineyard Sound and from Crab Ledge—a not unusual combination, as we have seen.

Although it is a problem to what degree depth, as such, can be regarded as a factor in determining the distribution of marine animals, we find of course many species which appear to show marked preferences for the deeper or the shoaler waters of the region. Among the echinoderms, it has already been pointed out that the sea urchin *Strongylocentrotus* occurs in Vineyard Sound chiefly at depths of 10 fathoms or more. The same is true to a less extent of *Asterias vulgaris*.[a] Now both of these have already been mentioned as northern forms, which are restricted in large measure to the colder waters of the region. Their avoidance of the shoaler waters near land is probably dependent upon their preference for lower temperatures.

Some of our local holothurians have a converse type of distribution; i. e., they show a decided preference for extremely shallow waters. To what degree this fact is related to temperature, and to what degree it depends upon the character of the bottom, in which they burrow, need not be considered here. One of this group, *Thyone briareus*, was dredged by us several times but never far from land, and its more characteristic habitat is probably in waters which are not accessible to the dredge at all.

The following is a list of the echinoderms which were taken by us in the course of the Survey dredging. The asterisk denotes as usual those species which were encountered at 10 or more stations in Vineyard Sound and Buzzards Bay, and for which, consequently, distribution charts have been plotted.

[a] To a certain degree *Henricia sanguinolenta* is more prevalent in the deeper waters. Only 7 per cent of our records for this species are from depths less than 5 fathoms, although 24 per cent of all our stations were at depths not exceeding that figure.

Solaster endeca.
*Henricia sanguinolenta (chart 47).
Asterias austera.
*Asterias forbesi (chart 48).
Asterias tenera.
*Asterias vulgaris (chart 49).
Ophioderma brevispina.
Ophiopholis aculeata.
*Amphipholis squamata (chart 50).
Amphioplus abdita.
Gorgonocephalus agassizii.
*Strongylocentrotus droebachiensis (chart 51).
*Arbacia punctulata (chart 52).
*Echinarachnius parma (chart 53).
Cucumaria pulcherrima.
Thyone briareus.
Thyone unisemita.
Caudina arenata.

Considering the 7 more prevalent species of local echinoderms, we may group them, as usual, according to their range upon our coast, as predominantly northern or southern. The distributions here stated are those given by Clark.

Predominantly northern.

Henricia sanguinolenta....."Greenland and Labrador to Connecticut, off New Jersey and even Cape Hatteras."
Asterias vulgaris....."Labrador to Cape Hatteras; but south of the Woods Hole region rarely seen in shallow water."
Strongylocentrotus droebachiensis.."Circumpolar; southward in the western Atlantic to New Jersey (not in shallow water south of Cape Cod)."

Predominantly southern.

Asterias forbesi....."Maine to the Gulf of Mexico, rare or local north of Cape Ann."
Arbacia punctulata....."Nantucket Shoals and Woods Hole to West Florida and Yucatan."

Of uncertain position.

Amphipholis squamata.....Arctic Ocean to West Indies and South America. (Australia; Mediterranean Sea.)
Echinarachnius parma.....On our coast, from Labrador to New Jersey (also Red Sea).

It is obvious that no fair opinion can be formed regarding the zoogeographical position of our local echinoderms from a consideration of these few species. According to Clark, 5 of the 6 true starfishes of the region are northern, though the Asteroidea are the only group which show this preponderance of northern forms.

7. ANNULATA AND SIPUNCULIDA.

ANNULATA.

Of the Annulata proper 148 determined species are recorded, to which number must be added 4 undetermined species and a few others which are doubtfully to be included in this list. These species represent 109 genera and 40 families. Of the total number of species recorded, 83, or more than 50 per cent, were taken during our own dredging operations; 46 others are recorded for local waters on the authority of persons who have participated in the work of the Survey, while 30 species are included wholly on the authority of published statements. The great majority of the segmented worms here recorded belong to the subclass Polychæta, of which about 135 species have been listed for the region. In addition to these, however, are 11 species of Oligochæta and 4 of the Hirudinea.

Only a single new species (*Arabella spinifera* Moore) has been described from specimens taken during the Survey dredging. A number of species hitherto unrecorded locally have, however, been added to the known fauna of the region. Such are *Myxicola steenstrupii, Pista intermedia, Polycirrus phosphoreus, Spiochætopterus oculatus, Spirorbis*

tubæformis, and some or all of the following:[a] *Amphitrite cirrata*, *Chætinopoma greenlandica*, *Cirratulus cirratus*, *Glycera capitata* and *Praxilella zonalis*.

Verrill and Smith (1873) listed 70 determined species of Annulata from specified localities lying within the limits of our region, and some 5 others whose range, as stated, would include Woods Hole and vicinity. Our present list thus comprises about twice as many representatives of this phylum as were catalogued for the region in the "Report upon the Invertebrate Animals of Vineyard Sound." More than 20 other determined species, however, were recorded at that time by Verrill for adjacent portions of the Atlantic coast; while in later papers he added many more to the fauna of the Woods Hole region itself. Most of those species of our own list which are not comprised within the various papers of Verrill have been recorded upon the authority of Dr. J. P. Moore, who has devoted some years to a systematic study of the Woods Hole Polychæta. Some of these, as above stated, were first taken during the survey dredging operations, while a yet greater number were collected independently by Dr. Moore before the latter operations were commenced. It is understood that Dr. Moore has noted the occurrence of a number of species which are not included in this report, but these records are unfortunately not available at present. Except in the case of certain familiar and easily determined forms, all of the annelids from the dredging collections were identified by the last-named zoologist, to whom we are likewise indebted for the revision of our check list of species. This authority is also responsible for the terminology adopted, though not, of course, for all the statements in the text.

Our list of Annulata considerably exceeds that given by Whiteaves for eastern Canada. Of the 105 Polychæta comprised in the latter catalogue, 29, or somewhat more than one-fourth, appear to be common to the Woods Hole region. None of the other groups of segmented worms have been considered by Whiteaves.

The total number of annelids listed in the Plymouth catalogue is surprisingly near to that in our own. The number of Polychæta is somewhat greater (148) in the former; the number of Oligochæta being smaller (only 3). Of the Plymouth Annulata, 10 of the Polychæta and 1 of the Oligochæta appear to be common to Woods Hole.

Herdman has listed 90(+2?) members of this phylum for the Irish Sea; while Græffe records 142 species for the Gulf of Trieste.

Certain defects of method must be taken into account in judging of the completeness of our dredging records for the annelids. As is well known, a large proportion of the species burrow in the sand or mud, in some cases quite deeply. When disturbed, they retreat hastily from the surface. In order to obtain such forms without mutilation, or in many cases even to obtain fragments of them, it is necessary to dig deeply into the soil. Dredges such as those employed in the present work removed, at best, but a few inches from the surface of the mud and sand, giving the burrowing worms an ample opportunity to escape.

An impressive instance of the incompleteness of our records for some of these burrowing annelids is furnished by the case of *Diopatra cuprea*. This species, as is well known, constructs a parchment-like tube, extending down some feet into the ground. The terminal, exposed portion of the tube is reinforced by any small bits of solid matter which happen to be at hand, e. g., pebbles, shell fragments, or bits of eel grass. By the exercise of considerable care the living worm may be dug up in shallow water. But

[a] These species were all dredged during the course of the survey. Whether or not they had previously been collected independently by Dr. Moore is not known.

although we have encountered these tubes (or rather short segments of tubes) at 198 stations throughout Vineyard Sound and Buzzards Bay, we have not a single record of having taken even the anterior portion of the worm itself in the course of our dredging. Our records for *Chætopterus pergamentaceus*, *Clymenella torquata*, *Melinna maculata*, and the two species of *Pista* likewise relate almost exclusively to tubes; although the first two of these species, at least, may be readily collected by digging in shallow water. It is highly probable also that some small and inconspicuous species were pretty constantly lost or overlooked in the process of washing large quantities of mud or sand, particularly as we were seldom assisted in the field by anyone having an adequate knowledge of this group.[a]

Mistakes due to the actual confusion of one species with another in the field records are probably particularly infrequent for the annelids, in as much as nearly all of the specimens were reserved for identification by Dr. Moore. The one known case in which a certain degree of confusion exists is that of the small tube-dwelling worms of the genus *Spirorbis*. It was not at first realized that several species of closely similar appearance existed within the limits of the region dredged, and for this reason it was not thought necessary to save samples from every dredge haul. It has consequently been found necessary to list a considerable proportion of our specimens merely as "*Spirorbis* sp. undetermined;" and it has not seemed worth while to present the distribution charts for any members of the genus, although at least one of these (*S. tubæformis*) is known to have been taken at more than 10 stations.

On the average, 4.3 species of Annulata were recorded for each of the Survey dredge hauls. The species found to have the most general distribution was *Hydroides dianthus*, which was taken at 223 of the 458 stations. Those encountered so frequently as to be taken at one-fourth of the total number of stations were:

Hydroides dianthus (223).
Diopatra cuprea (198).
Nereis pelagica (192).
Harmothoë imbricata (189).
Lepidonotus squamatus (165).

As might have been readily inferred from the habits of this group of organisms, the character of the bottom was found to be the dominant influence in determining their distribution. Now, we have seen that the bottom of Buzzards Bay, as a whole, is muddy, whereas most portions of Vineyard Sound, however much they differ in other respects, agree in the scarcity of mud. Accordingly we find it possible to divide the majority of the annelids from the Survey dredgings into predominantly Bay-dwelling and predominantly Sound-dwelling forms.

As judged by our dredging records, members of this phylum are encountered with considerably greater frequency in Buzzards Bay than in Vineyard Sound.[b] The average number of species taken per dredge haul for each body of water and for each vessel may be tabulated as follows:

Vineyard Sound:	
Fish Hawk stations	3.5
Phalarope stations	4.6
Buzzards Bay:	
Fish Hawk stations	6.2
Phalarope stations	4.6

[a] To obtain satisfactory results, portions of the bottom material should be covered with sea water and left standing in dishes for some hours.

[b] This statement is in no way inconsistent with the fact that the total number of species recorded for the Sound as a whole is considerably greater than that recorded for the Bay (p. 80).

It is to be noted that this preponderance in favor of the Buzzards Bay stations relates only to those of the *Fish Hawk*. It is in the deeper portions of the Bay, where the *Fish Hawk* dredgings were made, that the mud predominates. Elsewhere the bottom agrees more closely with that of Vineyard Sound.

These same facts are shown by a comparison of the lists of "prevalent" species for the different groups of stations (p. 65–71), i. e., the lists of those species which were taken at one-fourth or more of the stations belonging to each group. Thus the list for the *Fish Hawk* stations of Vineyard Sound contains five species; that for the *Fish Hawk* stations of Buzzards Bay, nine species. The list for the *Phalarope* stations in Vineyard Sound contains five species; that for the *Phalarope* stations of Buzzards Bay, six species.

With reference to the wealth of annelid life upon the three types of bottom which we have considered, we have the following figures, representing the average number of species per dredge haul: Sand, 3.4; stones and gravel, 4.7; mud, 5.2.

To what extent the greater wealth of annelid life upon muddy bottoms is actual and to what extent it is apparent can not be stated. Soft mud is of course cut into much more deeply with the dredge than is sand or gravel, and thus a larger proportion of the burrowing worms would be collected from the former type of bottom, even if they were equally common upon both.

Those species which were taken in one-fourth or more of the dredge hauls made upon sandy bottoms are:[a]

Harmothoë imbricata.
Nereis pelagica.
Diopatra cuprea.
Hydroides dianthus.
Lepidonotus squamatus.

It will be seen that this list comprises exactly the same species as were recorded for one-fourth or more of the total number of stations. It likewise comprises the same species as are to be found in the lists for both the *Fish Hawk* and *Phalarope* stations in Vineyard Sound.

The following is a list of prevalent species (according to the same standard) taken upon bottoms of gravel and stones:

Hydroides dianthus.
Nereis pelagica.
Lepidonotus squamatus.
Harmothoë imbricata.
Diopatra cuprea.
Pseudopotamilla oculifera.

The only one of these which was not comprised in the preceding list is the last one named.

The corresponding list for muddy bottoms is as follows:

Hydroides dianthus.
Diopatra cuprea.
Nephthys incisa.
Clymenella torquata.
Harmothoë imbricata.
Ninoë nigripes.
Cistenides gouldii.

Three of the foregoing species (*Hydroides*, *Diopatra*, and *Harmothoë*) were comprised in all of the preceding lists, and indeed they may be regarded as almost ubiquitous in local waters. The other four are to be regarded as characteristic of muddy bottoms, and indeed all of the seven appear among the "prevalent" species for the *Fish Hawk*

[a] In this and all similar lists, the species are arranged in the order of frequency.

stations in Buzzards Bay. The latter list is seen to be the most extensive one, so far as annelids are concerned. It will be found upon p. 66 and need not be repeated here.

Distribution charts (54–82) have been prepared for those 29 species (exclusive of *Spirorbis*) which were taken at 10 or more dredging stations. With respect to their distribution in local waters, we may arrange the species in the five following groups:

Species nearly or quite restricted to Vineyard Sound.

	Number of stations.
Eulalia annulata	17 Sound+[a] 1 Bay.
Lepræa rubra	22 Sound+ 1 Bay.
Polycirrus eximeus	10 Sound+ 0 Bay.

These species and some less frequent ones which might have been included are recorded almost exclusively from bottoms of sand or gravel. It is perhaps worth noting that the three listed are ones which are found most commonly in the interstices of the sandy ascidian, *Amaroucium pellucidum*. *Polycirrus eximeus* is recorded by us only from the eastern half of the Sound.

Species occurring predominantly in Vineyard Sound, though more or less common in Buzzards Bay.

	Number of stations.
Harmothoë imbricata	122 Sound+60 Bay.
Lepidonotus squamatus	113 Sound+44 Bay.
Nereis pelagica	152 Sound+23 Bay.
Lumbrineris hebes	15 Sound+ 5 Bay.
Pseudopotamilla oculifera	59 Sound+18 Bay.
Sabellaria vulgaris	60 Sound+12 Bay.

Reference to the charts shows that in the case of four of these six species, their occurrence in Buzzards Bay is in a large degree restricted to the inshore stations. This is a type of distribution which has been met with frequently, being exemplified by animals belonging to nearly all phyla. The comparative scarcity of mud at these inshore stations of the Bay is doubtless responsible for this peculiarity in their distribution.

Species nearly or quite restricted to Buzzards Bay.

	Number of stations.
Nephthys incisa	46 Bay+3 Sound.
Ninoë nigripes	38 Bay+1 Sound.
Rhynchobolus americanus	22 Bay+2 Sound.
Chætopterus pergamentaceus	43 Bay+0 Sound.
Spiochætopterus oculatus	35 Bay+2 Sound.
Pista intermedia[b]	18 Bay+2 Sound.
Melinna maculata	16 Bay+0 Sound.
Cistenides gouldii	37 Bay+0 Sound.
Maldane elongata	16 Bay+0 Sound.

Species occurring predominantly in Buzzards Bay, though taken occasionally in Vineyard Sound.

	Number of stations.
Pista palmata[b]	23 Bay+ 7 Sound.
Ampharete setosa	15 Bay+ 5 Sound.
Clymenella torquata	50 Bay+10 Sound.
Trophonia affinis	17 Bay+ 4 Sound.

[a] At mouth of Bay.

[b] Mostly inshore stations.

With a very few exceptions the last two lists comprise species which primarily inhabit muddy shores and bottoms. In the case of certain species (*Clymenella* and *Rhynchobolus*) it is to be noted that the few records of their occurrence in Vineyard Sound refer to areas whose bottoms are known to be partially muddy. This type of distribution is not, however, wholly intelligible in the case of *Clymenella torquata*, since it is known to occur in abundance in shores of pure sand. Unlike most of the foregoing species, *Pista palmata* and *P. intermedia* appear to be restricted, both in the Bay and in the Sound, to the adlittoral zone. They are found upon various types of bottom, including muddy ones. *Platynereis megalops* might perhaps have been included in the last of the foregoing lists, since it was recorded more frequently (absolutely as well as relatively) from Buzzards Bay. Like the two species of *Pista*, it was taken much more often at the inshore stations.

As the last of our groups with respect to distribution, we have:

Species exhibiting no evident preference for one or the other body of water.

	Number of stations.
Nephthys bucera	6 Sound+ 5 Bay.
Marphysa leidyi	7 Sound+ 5 Bay.
Diopatra cuprea	105 Sound+86 Bay.
Arabella opalina	27 Sound+17 Bay.
Parasabella microphthalmia	6 Sound+ 6 Bay.
Hydroides dianthus	130 Sound+93 Bay.

The distribution of most of these last species seems to be entirely independent of the character of the bottom. Two of them (*Diopatra* and *Hydroides*) are among the most ubiquitous of our local Annulata, though it is possible that the distribution of *Diopatra* is not so general as the wide-spread occurrence of its tubes would lead one to suppose. Regarding three of the foregoing species the records are too meager to permit of our forming any conclusions of value. *Nephthys bucera* is probably not of general occurrence in the Bay, since it is known to be predominantly a sand-dwelling species.

The temperature factor, which has been shown to be such an important one in determining the distribution of many species belonging to other groups of organisms, probably applies to certain of the local annelids, though it appears to play a relatively insignificant part with respect to the species for which charts have been plotted. The only case among the latter which seems to fall under this head is that of the serpulid worm *Hydroides dianthus*. The absence of this species from the western portion of Vineyard Sound is a conspicuous feature in its distribution, especially when coupled with the fact that it has not once been recorded from Crab Ledge, despite the favorable bottom at the latter point. It is of probable significance in this connection that *Hydroides* is predominantly a southward-ranging species, which may, on this account, be poorly adapted to the colder waters of the region. The case resembles that of the coral *Astrangia* (p. 99) and that of the sea urchin *Arbacia* (p. 113), which have already been discussed from this point of view. So far as our records go, however, there are in Vineyard Sound none of those characteristic cold-water species which are confined to the neighborhood of the open ocean. But there are a number of species of annelids recorded from the Crab Ledge stations alone among the dredgings of the survey. For most of such species Cape Cod is believed to lie at the southern limit of distribution. Some of these are included in the following table. The statements as to range have been furnished us by Dr. Moore.

Northern types taken only at Crab Ledge.

Ammotrypane fimbriata	Gulf of Maine to Vineyard Sound.
Amphitrite cirrata	Northern Europe to Crab Ledge.
Chætinopoma greenlandica	Northern seas, south in deep water to Massachusetts.
Eunoë oerstedi	Greenland to Vineyard Sound.
Filograna implexa	North Atlantic, south to Nantucket; off Sankaty Head.
Glycera capitata	Northern Europe to Crab Ledge.
Nothria conchylegia	North Atlantic, south to Cape Cod.
Myxicola steenstrupii	North Atlantic, south to Massachusetts.
Thelepus cincinnatus	North Atlantic, south to Massachusetts.

The low temperature of the bottom waters at Crab Ledge was considered on p. 51 and has been referred to elsewhere in our discussions of distribution.

Attention has already been called to the fact that a number of our charted species of annelids are recorded primarily from the inshore (adlittoral) stations, both in the Bay and in the Sound. This is true of *Pista palmata*, *Pista intermedia*, *Parasabella microphthalmia*, and in a lesser degree of *Platynereis megalops*. The same phenomenon is exhibited by certain less common species, such as *Sthenelais picta* and *Dodecaceria coralii*. All of these species were recorded wholly or chiefly from the *Phalarope* and *Blue Wing* stations.

On the other hand, certain species appear at first sight to show a tendency exactly the opposite of that manifested by those just mentioned. These others were encountered with considerable frequency during the *Fish Hawk* dredging, but were seldom taken by the *Phalarope*. Examples of such species are *Eulalia annulata*, *Nephthys bucera*, *Ninoë nigripes*, *Arabella opalina*, and *Rhynchobolus americanus*. As a matter of fact, however, the last two species, at least, are known to be common along shore, where they may be dug up with the spade. Their absence from the *Phalarope* records is very probably due to the failure of the dredges employed on the latter vessel to cut deeply enough into the bottom. Indeed, it is quite possible that this same explanation will hold for most of the cases in which species of Annulata seem to be restricted to the *Fish Hawk* stations.

And, in general, when we are considering any case in which a given species has been obtained almost exclusively by one or the other vessel, the question must be asked whether the personal element may not have played a part in determining this result. It has been stated that the *Fish Hawk* and *Phalarope* dredgings were under the supervision of different persons. As is well known, different observers see different things, depending upon what has especially been brought to their notice. We do not believe however, that much importance need be attached to this source of error in considering most of the species which have been listed here. In the case of certain of those which have been mentioned as having a predominantly adlittoral habitat (e. g., *Pista intermedia*), it is noteworthy that even the *Fish Hawk* stations at which they were taken were mainly near shore.

A considerable number of the Annulata, the names of which appear in our faunal catalogue, are strictly intertidal in their habitat, or at least are confined to the shallow waters just below the tidal limits. Such forms have naturally not been taken with the dredge, although many of them are common enough in their proper habitat. Examples of species such as these are *Podarke obscura*, *Nereis limbata*, *Scoloplos fragilis*, *Amphitrite ornata*, *Notomastus luridus*, *Arenicola cristata*, *Arenicola marina*, *Spirorbis spirorbis*,

and all of the Oligochæta so far as listed. As has already been stated, it is likely that most of the benthic species extend nearly or quite up to the littoral zone; and indeed they often occupy the latter as well.

On the other hand, many of our local Annulata are pelagic during a part, at least, of their existence. This is true of the larvæ of nearly all the Polychæta, and holds for the sexual phase of many adult worms, particularly the Syllidæ and Nereidæ. One highly modified and typically pelagic form, *Tomopteris helgolandica*, is taken in the local tow during the winter and spring, sometimes occurring in abundance. Two exotic species, which may perhaps be termed pelagic, were found upon floating timbers among goose barnacles. These are *Amphinome pallasii*[a] and *Hipponoë gaudichaudi*.

A few of the more striking examples of a difference of habitat being shown by different members of the same genus are as follows:

Nephthys.
N. incisa: Frequents bottoms of soft mud.
N. bucera: Frequents sandy bottoms.
Nereis.
N. pelagica: Clear waters, non-muddy bottoms.
N. limbata: Strictly littoral, preferring foul and brackish waters.
N. virens: Diverse habitat.
Cirratulus.
C. grandis: Shores and deeper waters in sand and gravel.
C. parvus: Deeper waters only, in colonies of Amaroucium pellucidum.
Amphitrite.
A. ornata: Inner waters of region, strictly littoral.
A. brunnea and A. cirrata: Only recorded from Crab Ledge.
Pista.
P. palmata: Said to frequent purer waters and cleaner sand than P. intermedia.
Spirorbis.
S. spirorbis: On rock-weed, littoral.
S. tubæformis: On Phyllophora and Chondrus, from adlittoral zone to greatest depths of region.
S. quadrangularis: At Crab Ledge only.
S. stimpsoni: At Crab Ledge only.
S. fewkesi: From algæ in deeper waters of Vineyard Sound.

The following species of Annulata were taken during the dredging operations of the Survey:

Autolytus ornatus.
Eusyllis fragilis.
Odontosyllis lucifera.
Pædophylax dispar.
Syllis pallida.
Trypanosyllis sp.
*Eulalia annulata (chart 54).
Eulalia gracilis.
Eulalia pistacia.
Eumidia americana.
Phyllodoce catenula.
Eunoë oerstedi.
*Harmothoë imbricata (chart 55).
*Lepidonotus squamatus (chart 56).
Lepidonotus sublevis.
Sigalion arenicola.
Sthenelais gracilis.
Sthenelais picta.
*Nephthys bucera (chart 57).
*Nephthys incisa (chart 58).
Nereis arenaceodentata.
Nereis dumerilii.
*Nereis pelagica (chart 59).
Nereis virens.
*Platynereis megalops (chart 60).
*Marphysa leidyi (chart 61).
*Diopatra cuprea (chart 62).
Nothria conchylegia.
*Arabella opalina (chart 63).
Drilonereis longa.

[a] This, we learn, is known to be littoral in the West Indies.

*Lumbrireris hebes (chart 64).
Lumbrineris tenuis.
*Ninoë nigripes (chart 65).
Euglycera dibranchiata.
Glycera capitata.
*Rhynchobolus americanus (chart 66).
Scoloplos fragilis.
Scoloplos robustus.
Polydora concharum.
Scolecolepis viridis.
Spio sp. undet.
*Chætopterus pergamentaceus (chart 67).
*Spiochætopterus oculatus (chart 68).
Ammochares artifex.
Cirratulus cirratus.
Cirratulus grandis.
Cirratulus parvus.
Cirratulus tenuis.
Dodecaceria coralii.
Amphitrite cirrata.
*Lepræa rubra (chart 69).
Nicolea simplex.
*Pista intermedia (chart 70).
*Pista palmata (chart 71).
*Polycirrus eximeus (chart 72).
Thelepus cincinnatus.
Sabellides pusilla.
*Ampharete setosa (chart 73).
*Melinna maculata (chart 74).
*Cistenides gouldii (chart 75).
Capitella sp.
Ammotrypane fimbriata.
Ophelia denticulata.
*Clymenella torquata (chart 76).
*Maldane elongata (chart 77).
Praxilella zonalis.
Scalibregma brevicauda.
Brada setosa.
*Trophonia affinis (chart 78).
Euchone elegans.
Myxicola steenstrupii.
*Parasabella microphthalmia (chart 79).
*Pseudopotamilla oculifera (chart 80).
Protula sp.
Chætinopoma greenlandica.
Filograna implexa.
*Hydroides dianthus (chart 81).
Spirorbis quadrangularis.
Spirorbis spirillum (probably taken more than ten times).
Spirorbis tubæformis.
*Sabellaria vulgaris (chart 82).
Ichthyobdella funduli.

If we classify our 30 commoner species of bottom-dwelling annelids as predominantly northern or southern, according to their known range upon our coast, we have the following groups:[a]

Predominantly northern.

Harmothoë imbricata.....Circumboreal; south on our coast to New Jersey.
Lepidonotus squamatus.....Both sides of North Atlantic; Greenland to South Carolina; also reported from north Pacific.
Nephthys incisa.....Spitzbergen to Long Island Sound.
Nereis pelagica.....Greenland and Labrador to Beaufort, N. C., becoming smaller and less common south of Vineyard Sound.
Ninoë nigripes.....Eastport, Me., to Block Island.

Predominantly southern.

Eulalia annulata.....Provincetown, Mass., to New Jersey.
Nephthys bucera.....Massachusetts Bay to Charleston, S. C.
Platynereis megalops.....Cape Cod to Beaufort, N. C.
Marphysa leidyi.....Massachusetts to North Carolina.
Diopatra cuprea.....Cape Cod to Charleston, S. C.
Arabella opalina.....Massachusetts to Porto Rico.
Rhynchobolus americanus.....Massachusetts to Charleston, S. C.
Chætopterus pergamentaceus...Cape Cod to West Indies.
Spiochætopterus oculatus.....Wellfleet, Mass., to Virginia.
Lepræa rubra.....Massachusetts to North Carolina.
Pista palmata.....Cape Cod to Virginia.

[a] The ranges are stated upon the authority of Dr. Moore.

Polycirrus eximeus.....Cape Cod to Beaufort, N. C
Ampharete setosa.....New Haven to east of Falmouth.
Melinna maculata.....Woods Hole to Virginia.
Cistenides gouldii.....Casco Bay to North Carolina.
Clymenella torquata.....Eastport, Me., to Porto Rico.
Maldane elongata.....Massachusetts to North Carolina.
Trophonia affinis.....Massachusetts Bay to southern New Jersey.
Parasabella microphthalmia....Massachusetts Bay to Beaufort, N. C.
Hydroides dianthus.....Casco Bay (in sheltered places) and Massachusetts Bay to Charleston, S. C.
Spirorbis tubæformis.....Vineyard Sound to New Haven.
Sabellaria vulgaris.....Provincetown to Beaufort, N. C.

Having a range of approximately equal extent north and south.

Lumbrineris hebes .....Casco Bay to New Jersey.
Pseudopotamilla oculifera.....Bay of Fundy to Virginia.

Of doubtful position.

Pista intermedia.....Cape Cod to Block Island.

It will thus be seen that a large majority of the more prevalent benthic species of Annulata found in this vicinity are predominantly southern in their range, while of the few species whose range is predominantly northern all but two have a range which extends far to the southward of Woods Hole.

SIPUNCULIDA.

So far as known, this group of worms has a scant representation in our local fauna. Only three determined species are included in our list, of which only one (*Phascolion strombi*) was encountered with any frequency in the dredge. This was mainly recorded from the inshore stations of Buzzards Bay, though taken elsewhere on a number of occasions (chart 83). On account of its peculiar mode of life it was probably frequently overlooked during the earlier days of our dredging. This worm, according to Gerould, is "found all along the eastern coast of North America from off Virginia northward to Labrador." Since it occurs in such widely different latitudes as the West Indies and the northern coast of Asia, the distribution of this species can have little relation to temperature.

Another of our local sipunculids (*Phascolosoma verrillii* Gerould) has been taken on a very few occasions only. It was apparently observed by Verrill, though not described by him.

8. ARTHROPODA.

With a few exceptions the phylum Arthropoda is represented in our marine fauna by the class Crustacea alone, the members of which occupy somewhat the same position in the life of the sea as do the insects upon land. The total number of Crustacea thus far listed for this region is about 300, which is a larger number than is recorded for any other class of animals or even for any entire phylum besides the Arthropoda. There are comprised in our catalogue 289 definitely determined species of Crustacea, together with 3 which are undetermined and 18 which have been determined with doubt. Of these, 126(+6?) are to be assigned to the subclass Entomostraca and 163(+15?) to the subclass Malacostraca. Since the former subclass comprises for the most part small

and inconspicuous forms, it is likely that the list of these is far less complete than that for the latter group, which comprises, for the most part, species of moderate or large size. It is the Malacostraca, likewise, which are chiefly represented in our dredging records; indeed, we should say *exclusively* represented but for the ever-present barnacles.

Owing to the magnitude of this class and to the fact that different sections have been treated by different specialists, it seems best to consider the orders separately.

I. PHYLLOPODA.

The Phyllopoda are represented in our list by two members of the Polyphemidæ, which were identified by Mr. R. W. Sharpe among material collected with the townet at Woods Hole, and by a species of *Artemia*, which was observed by Verrill in "salt vats" at Falmouth, and is perhaps not to be included in our marine fauna at all. One or more species of Polyphemidæ are at times excessively abundant in the Woods Hole plankton, and it is likely that our phyllopod fauna is far more extensive than the present meager records would imply.

II. OSTRACODA.

Twenty-six species of ostracods have been identified by Dr. Cushman[a] among specimens collected in the vicinity of Woods Hole. Of these, 21 were recorded from the Survey dredgings. Since this group had never been studied locally prior to the work of Dr. Cushman, all of these 26 species may be regarded as additions made to our local fauna through the operations of the Survey. Ten of them were described for the first time by Dr. Cushman from specimens dredged or otherwise collected during the summer of 1905.

Mr. R. W. Sharpe, who has examined large quantities of townet material collected in Woods Hole Harbor, believes that he has met with "perhaps 20 forms, certainly new to our shores, and mostly new to science." Thus far, however, he has not published descriptions of any of these local species.

Reference to the comparative table on page 88 shows that 29(+9?) species of ostracods have been listed for eastern Canada, 6 for Plymouth, 57(+1?) for the Irish Sea, and 9 for the Gulf of Trieste. It is likely that these numbers represent the relative thoroughness of the search which has been made for these organisms rather than the relative wealth of species at these points. Ten of the Canadian species are known to be common to Woods Hole, but so far as we may infer from the lists there are no species common to Woods Hole and Plymouth.

None of the Ostracoda were recorded from a sufficient number of dredging stations to warrant our plotting distribution charts for them. Moreover, they were only sought for during one season of the regular dredging work of the Survey[b] and consequently we have a very imperfect idea of their distribution in local waters. From our records the ostracods appear to be chiefly restricted to the western end of Vineyard Sound, and it seems likely that their scarcity in the eastern part is in a considerable measure real, since bottom samples from the entire length of the Sound were examined by Dr. Cushman.

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[a] A list of these has already been published in Proceedings of the Boston Society of Natural History, vol. 32, 1906.

[b] A few additional records were obtained in 1907.

III. COPEPODA.

These fall into two rather natural subdivisions, including the free-living and the parasitic forms, respectively, though the line of division is not strictly a taxonomic one. The list of free-living copepods, including 25 (+1?) species, is derived from the published reports of W. M. Wheeler (1900) and of R. W. Sharpe (1910).[a] Wheeler listed 30 species for the "Woods Hole Region," though the majority of these were recorded only from waters lying well without the limits of the region considered in the present report. Mr. Sharpe examined collections taken by himself in the tow net throughout the season of 1908, as well as material which had already been gathered by the schooner *Grampus* and by Mr. V. N. Edwards. He has catalogued 60 species, of which, however, more than half are extralimital.

The parasitic copepods of this region, of which 58(+2?) species are comprised in our catalogue, have been listed by S. I. Smith (in Verrill and Smith, 1873), R. Rathbun (1884–1887), M. J. Rathbun (1905), and by C. B. Wilson in a series of recent papers. We are indebted to the last-named authority for examining the manuscript of our annotated list of this group, as well as for furnishing a valuable set of notes which have been incorporated in the latter. The nomenclature and the classification adopted are his.

Scarcely any copepods, either free or parasitic, are recorded in the Canadian catalogue of marine invertebrates. The Plymouth list comprises 24 free-living species and one parasitic. Herdman has listed 195 copepods (chiefly free-living) from the Irish Sea, while Graeffe's catalogue for the Gulf of Trieste includes 56 free-living copepods and 110 parasitic species. Here again, it is quite unlikely that these figures are at all indicative of the actual wealth of the copepod fauna at the respective points.

IV. CIRRIPEDIA.

Of this order, 17 species are listed for the region, though two of these are included somewhat doubtfully. Of these only two (*Balanus eburneus* and *B. porcatus*), and possibly a third (*B. crenatus*), have been taken during our Survey dredging. Most of the species listed in the catalogue have, however, been collected at one point or another by our parties. One species, *Chthamalus stellatus*, although very abundant at present, seems to have escaped the notice of local zoologists and had not apparently been recorded for New England waters until attention was recently called to it by one of the present writers.[b] Another (*Balanus tintinnabulum*) had not, so far as we know, been definitely recorded for points within the region. This last is, however, an exotic form, and is not, probably, to be included in our fauna.

Verrill and Smith (1873) listed 13 species of barnacles, most of which, however, were not recorded from definitely indicated points within the limits of our region. All but one of our 17 species are included by Miss Rathbun in her "List of the Crustacea," though not in all cases recorded for strictly local waters.

Scant attention has been given, however, to the sessile barnacles of our coast, and it is not unlikely that further studies will considerably increase the number of known species. Notwithstanding this probable incompleteness of our list, it will be seen

[a] The list of Rhode Island species prepared by Williams (1906) has not been considered here, since the records relate only to Narragansett Bay.

[b] Science, Sept. 17, 1909. (See also footnote on page 190 of this report.)

(p. 89) that a greater number of cirripedes have been catalogued from Woods Hole than from any of the other stations considered in our table. Only 10 species each have been listed by Whiteaves, Herdman, and the Plymouth laboratory, while 15 have been recorded by Graeffe. Six of the Canadian species and 4 of those listed for Plymouth are common to our Woods Hole catalogue.

The barnacles, particularly the sessile forms, are a very baffling group to the taxonomist, and it must be admitted that our local collections have not received the treatment which they deserve. During the greater part of the Survey dredging separate specimens were preserved from each station at which barnacles were taken. A large proportion of these specimens were immature, many others were waterworn and imperfect. The small collection made during the summer of 1903 was examined by Dr. H. A. Pilsbry, who furnished a list of identifications covering this earlier period. The survey was unable to obtain the services of this specialist in determining the barnacles dredged during the subsequent seasons of the work.[a] This task was finally undertaken by the senior author of this report, who offers his results with considerable reservation. Attention must be called to the frequently reiterated statements of Darwin, the chief monographer of this group, respecting the high variability and the indefinite limits of the species of *Balanus*. As evidence of the impossibility of distinguishing these species by external characters, he writes (Monograph of the Cirripedia, vol. II, p. 187): "After having described nearly 40 species, and when my eye was naturally able to appreciate small differences, I began carefully to examine varieties of *B. tintinnabulum*, *amphitrite*, *improvisus*, *porcatus*, *vestitus*, etc., without even a *suspicion* that they belonged to these species, at that time thoroughly well known to me." It must be added, however, that the case is far less difficult to one who deals with a very few species occupying a very limited area. Unless certain species which have never been reported from the Woods Hole Region are nevertheless common here, our determinations are probably correct in the great majority of cases.

By far the larger proportion of specimens coming from the Survey dredgings which have been examined have been referred to *Balanus eburneus*. Large specimens of this species, found upon the bottom of a boat and elsewhere, have been studied carefully, with reference both to the internal and external structure of the shell. The same careful examination was extended to certain of the specimens coming from the dredgings. None of the latter, however, nearly equaled in size the examples taken from woodwork in shallow water, and are probably for the most part immature. The longitudinal striation of the terga is faintly indicated, or altogether wanting, and the general shape of the opercular plates differs from those taken from adult specimens. It must be confessed, therefore, that general appearance and the process of elimination have led us to our decision in regard to most of these specimens. They are obviously not to be referred to *Balanus balanoides*, for they have a shelly base, and differ in other conspicuous ways. Moreover, the latter species is strictly intertidal in its habitat. Nor are they to be assigned to *Balanus crenatus*, *B. porcatus*, or, indeed, to any of the other species which have thus far been recorded from this region. At least one source of serious confusion seems to be possible, however. Darwin tells us that "diagnosis

[a] We are indebted to him, however, for the identification of a considerable number of stalked barnacles of the genera *Lepas* and *Conchoderma*.

is most difficult without long practice" between immature specimens of *B. eburneus* and the young of *B. improvisus*. According to both Darwin and Gruvel, the latter species is recorded from Nova Scotia and the coast of the United States, though no definite localities are stated. Thus it does not seem unlikely that this species occurs in our local waters and that it may have hitherto been confused with *Balanus eburneus*. Barring this possibility, however, of a confusion with some closely similar species which has not been recorded from local waters, it is probable that nearly all of the barnacles dredged by the Survey are to be assigned to *Balanus eburneus*. Acting upon this supposition, we have plotted out a single distribution chart based not only upon the specimens which have been identified as *Balanus eburneus* but upon those which, owing to immaturity or poor preservation, could not be identified with confidence. The two sets of records have, however, been separated in the faunal catalogue.

The chart (84) shows us that this species is of general occurrence and of considerable abundance throughout both the Sound and the Bay. It was recorded from 157 stations, or somewhat more than one-third of the total number dredged. The specimens which were dredged were commonly attached to stones or shells, very frequently to shells which were occupied by hermit crabs. This last circumstance may account, in some measure, for the very general distribution of this species upon the local sea floor. *Balanus eburneus* occurs at all depths within our region, even extending up to the neighborhood of the low-water mark, where its zone overlaps that of *B. balanoides*.[a]

The range of *Balanus eburneus*, according to Darwin, is from Massachusetts ("about lat. 42°") to Venezuela and the West Indies. It thus falls within the class of southward-ranging species.

Barnacles of one (perhaps two) other species were dredged by us. Large specimens of *Balanus porcatus* were taken at Crab Ledge, and at least one specimen of this same species was taken in Vineyard Sound. Other worn shells, which are believed to be those of either *B. porcatus* or *B. crenatus*, were dredged on several occasions in the Sound. The latter species was said by Verrill to be "abundant" in Vineyard Sound, but this is directly contradicted by our own experience, though we have found it growing in considerable numbers upon piles at Vineyard Haven.

Above low-water mark *Balanus balanoides* occurs in prodigious profusion, being one of the most abundant and conspicuous members of our littoral fauna. With it upon rocks and piles, though commonly at a somewhat higher level, is to be found *Chthamalus stellatus*, which is likewise abundant and generally distributed along our shores locally.

A number of species of stalked barnacles of the genera *Lepas* and *Conchoderma* are included in our list. Several of these species, notably *Lepas fascicularis*, *L. hilli*, and *L. anatifera*, are sometimes found in considerable profusion. They are, however, pelagic organisms which find their proper home in the open sea.

[a] We have found *Balanus balanoides*, *B. eburneus*, *B. crenatus*, and *Chthamalus stellatus* growing together on a single piece of bark removed from a wharf pile at Vineyard Haven.

V. AMPHIPODA.

Locally, at least, the amphipods are by far the most abundant of the Malacostraca, both in respect to the number of individuals and of species. Seventy-one determined species are recorded for the region, to which number must be added 6 which are listed as undetermined or are doubtfully to be included in this list. These species belong to 54(+5?) genera and 22(+2?) families. Of the total number of species recorded, 35, or about one-half, have been taken during our own dredging operations; 26 others have been identified from shore or townet collections made during the progress of the survey; while the remainder are recorded solely upon the authority of published statements.

None of the species encountered during the present work have been described as new to science, though it is believed that the collections contain one or more undescribed species. About nine species have been added to the fauna of the region either through our dredging operations or through the identification of material in the possession of the laboratory.

Verrill and Smith (1873) listed 31 species of amphipods, of which only 16 were determined species recorded for specified localities within the region. Many of the others must, however, have been observed in local waters, although the ranges were stated in general terms.

Holmes (1905) lists 79 determined species of amphipods, some of which were first described in his report of that date. From this number, however, must be deducted about 20 species which were not recorded for points within the area at present under consideration. Miss Rathbun, in her "List of the Crustacea," includes over 100 species and varieties for the whole of New England, but a considerable proportion of these are extralimital as regards our present region.

The list of invertebrates for eastern Canada comprises 70(+4?) species of amphipods, a number almost identical with our own. Of these, 20 are known to be common to the two lists. The Plymouth catalogue records 52 members of this order, of which only 7 or 8 appear to be common to our Woods Hole fauna. Herdman catalogues 129 species for the Irish Sea, while Graeffe lists 49(+1?) for the Gulf of Trieste.

Since the amphipods are contained very largely in the sand and mud brought up by the dredge, the completeness of the record for any region depends, of course, upon the character of the bottom sample obtained and upon the thoroughness with which it is subsequently washed. Thus in the first season (1903) few amphipods were listed, owing to the imperfect methods then employed. Another possible source of error is the likelihood of free-swimming species from any depth being caught in the dredge during the passage of the latter through the water after leaving the bottom. Thus, some of those amphipods which constitute at times such an important element in the plankton may figure as bottom dwelling species in the records. It is believed that cases of this sort are comparatively few, however, owing to the probability that these free-swimming species would pass out through the meshes of a dredge net.

With a few exceptions no effort was made to identify the amphipods in the field, but the specimens from each station were preserved for future determination. For the identification of many of these we are under obligation to Prof. S. J. Holmes, to whom we are likewise indebted for a critical examination of our check list of amphipods. The greater part of the work of identification was, however, performed by Dr. Cole. A

large collection of specimens taken by Mr. Edwards with the tow net, or gathered by the Survey parties during the shore collecting, has been identified for us by Dr. B. W. Kunkel. A few of the readily recognizable forms (e. g., *Unciola irrorata*) were frequently listed in the field. Unfortunately during the first season all the Caprellidæ were recorded by the collectors as "*Caprella geometrica.*" Since some other members of this genus have been recorded from the region, and particularly since the allied *Æginella longicornis* is found with great frequency, such records are, of course, equivocal, and they have been changed to "Caprellidæ sp." Later dredgings have, however, resulted in differentiating to some degree the distributions of these species, but not sufficiently to warrant our plotting out a separate chart for each. We have consequently prepared a single chart showing their combined distribution.

On the average 1.6 species of amphipods are recorded for each of the Survey dredge hauls. The species found to have the most general distribution was *Unciola irrorata*, which was taken at 115 of the regular dredging stations. No other member was encountered at as many as one-fourth the entire number of stations.

The most salient fact respecting the distribution of the bottom-dwelling amphipods in local waters is the paucity of species in Buzzards Bay as compared with Vineyard Sound. In fact, of the 19 species for which distribution charts have been plotted, only 2 are shown to be of greater abundance in the Bay, while not more than 2 others seem to be present in about equal numbers in the two bodies of water. We may for convenience group the species as follows with reference to their comparative abundance in one or the other body of water.

Species wholly or chiefly restricted to Vineyard Sound.

	Sound stations.	Bay stations.
Lysianopsis alba	11	2
Haustorius arenarius	11	1
Byblis serrata	16	4
Calliopius læviusculus	15	0
Pontogenia inermis	25	2
Batea secunda	24	1
Gammarus annulatus	9	1
Elasmopus lævis	30	3
? Autonoë smithi (data too few)	12	5
Amphithoë, rubricata	32	9
Jassa marmorata	16	1
Ericthonius minax	31	1
Corophium cylindricum	59	7
Æginella longicornis / Caprella geomtrica	78	7

Species chiefly restricted to Buzzards Bay.

Ampelisca macrocephala	4	27
Ptilocheirus pinguis	14	42

Species of nearly unrestricted distribution.

Ampelisca spinipes	32	23
Unciola irrorata	70	40

With the exception of those four species comprised in the last two lists, the amphipods, when recorded from Buzzards Bay at all, were nearly always taken in the vicinity of land, i. e., at the adlittoral stations. In a large proportion of cases the Bay stations were near the passages connecting with Vineyard Sound, or close to the lower end of the Bay.[a]

On the other hand, even within the Sound, certain species are found not to have an unrestricted distribution. For example, *Haustorius arenarius*, *Byblis serrata*, *Calliopius læviusculus*, *Pontogenia inermis*, and *Jassa marmorata* are in large degree restricted to the western half of the Sound, while *Lysianopsis alba*, *Batea secunda*, and *Autonoë smithi* are for the most part restricted to the eastern half. One of the two predominantly Bay-dwelling species (*Ampelisca macrocephala*) and perhaps also the other (*Ptilocheirus pinguis*) appear to be in some measure restricted in the Sound to points where the bottom is muddy. The difference between the Bay and the Sound in respect to tneir amphipod faunas, and in considerable measure the local distribution within each of these bodies of water, are for the most part explainable by reference to the character of the bottom. Just such types of distribution have already been encountered in the case of other groups and need not be discussed here. Certain cases which appear to be explainable by reference to temperature will be considered shortly.

An interesting feature respecting the amphipod life of the Bay and the Sound appears when we consider the average number of species taken per dredge haul for each body of water and for each vessel. The figures are as follows:

Vineyard Sound:	
Fish Hawk	1.8
Phalarope	1.9
Buzzards Bay:	
Fish Hawk	1.3
Phalarope	1.1

While these figures were considerably higher for the Sound stations than forthe Bay stations, there is nothing like the disproportion which might have been expected in view of the fact that the number of predominantly Sound-dwelling species which were shown upon our charts was so much in excess of (7½ times) the number of predominantly Bay-dwelling species.

Again, the average number of species per dredge haul is the same (1.6) for each of the three types of bottom distinguished. And when we consider the lists of "prevalent" species for the various groups of stations, we find that only such one (*Unciola irrorata*) occurred at one-fourth of the Vineyard Sound stations of the *Fish Hawk*, while three species (*Ptilocheirus pinguis*, *Unciola irrorata*, and *Ampelisca macrocephala*) occurred at an equal proportion of Buzzards Bay stations. This condition seems to be only explainable on the supposition that while the number of species which inhabit Vineyard Sound is greatly in excess of the number found in Buzzards Bay, such species as do occur in the latter are of much more general prevalence throughout its extent. A discussion of similar phenomena has already been given in chapter III.

Two apparent cases of distribution in relation to temperature are *Calliopius læviusculus* and *Pontogenia inermis*, which occur, so far as our dredging records show, primarily

[a] In some cases, just without. Here and elsewhere stations have been classed as Bay or Sound stations which lay on the Bay or Sound sides, respectively, of Sow and Pigs Reef, extending from the end of Cuttyhunk Island.

in the colder region of the Sound. Both of these are predominantly northern species, as will be seen by reference to the table on page 135, giving the ranges of some of the local amphipods. It must be added, however, that the first species is taken throughout the year in the surface tow at Woods Hole and has been collected along shore at various local points even in midsummer. In the case of two other species, *Byblis serrata* and *Haustorius arenarius*, there appears to be likewise to some extent a preference for the western extremity of Vineyard Sound. Neither of these, so far as known, are predominantly northern species, and it is likely that the character of the bottom is the determining factor in their distribution, particularly since *Haustorius* is known to be abundant on sand flats near shore. Its preference for the western portions of the Sound is thus comparable with that of the lady crab, *Ovalipes ocellatus*. A few species, on the other hand, appear from our rather meager records to occur predominantly in the warmer waters of the region. Such are *Lysianopsis alba*, *Batea secunda*, and *Autonoë smithi*. All of these have been recorded only for the immediate neighborhood of Woods Hole, and their general distribution is unknown. Little stress is to be laid upon any of these cases, however, especially since a number of other species which here reach their northern or their southern limit are distributed locally without any apparent reference to temperature.

Amphithoë rubricata alone, among those species whose distributions have been plotted with any degree of completeness, seems to be restricted to the littoral and adlittoral zones. It is recorded chiefly from the inshore stations dredged by the *Phalarope* and *Blue Wing*, and the comparatively few *Fish Hawk* stations at which it was taken are all in the neighborhood of land.

The following amphipods were recorded during the Survey dredging, those taken at 10 or more stations being designated as usual by an asterisk:

?Talorchestia megalophthalma (perhaps not from bottom).
Anonyx nobilis (generic name questionable).
*Lysianopsis alba (chart 85).
*Haustorius arenarius (chart 86).
Phoxocephalus holbolli.
Paraphoxus spinosus.
*Ampelisca macrocephala (chart 87).
*Ampelisca spinipes (chart 88).
*Byblis serrata (chart 89).
Stenothoë minuta.
Sympleustes latipes.
*Calliopius læviusculus (chart 90).
*Pontogenia inermis (chart 91).
Dexamine thea.
*Batea secunda (chart 92).
Gammarus locusta.
*Gammarus annulatus (chart 93).
*Elasmopus lævis (chart 94).
Gammarellus angulosus.
Microdeutopus danmoniensis.
*Autonoë smithi (chart 95).
*Ptilocheirus pinguis (chart 96).
Podoceropsis nitida.
*Amphithoë rubricata (chart 97).
Amphithoë longimana.
Sunamphithoë pelagica.
Ischyrocerus anguipes.
*Jassa marmorata (chart 98).
Grubia compta.
Ericthonius rubricornis.
*Ericthonius minax (chart 99).
*Corophium cylindricum (chart 100).
*Unicola irrorata (chart 101).
*Æginella longicornis, *Caprella geometrica (chart 102, "Caprellidæ sp.").

The 19 commonest species of amphipods are herewith grouped with reference to their known range upon our coast. The ranges stated are those given by Holmes (1905).

Northward ranging.

Ampelisca macrocephala.....Off Halifax to Newport.
Calliopius læviusculus.....Greenland to Narragansett Bay.
Pontogenia inermis.....Arctic Ocean to Vineyard Sound.
Ptilocheirus pinguis.....Labrador to New England.
Amphithoë rubricata.....Labrador to Newport.
Unciola irrorata.....Greenland to New Jersey.
Æginella longicornis.....Greenland to Narragansett Bay.

Southward ranging.

?Haustorius arenarius.....Cape Cod to Georgia, Norway, British Isles.
Elasmopus lævis.....Provincetown, Mass., to New Jersey.
Ericthonius minax.....Vineyard Sound to Great Egg Harbor, N. J.
Corophium cylindricum.....Provincetown, Mass., to New Jersey.
Caprella geometrica.....Southern coast of New England to Virginia.

Of uncertain position.

Lysianopsis alba.....Woods Hole.
Ampelisca spinipes.....Long Island Sound, Woods Hole. (Norway.)
Byblis serrata.....Woods Hole, Newport.
Batea secunda.....Woods Hole.
Gammarus annulatus.....Vineyard Sound, Gloucester.
Autonoë smithi.....Vineyard Sound and Buzzards Bay.
Jassa marmorata.....Woods Hole region.

Thus there seems to be a slight excess of northern over southern species among those 19 amphipods which we have dredged most frequently. Little importance is to be attributed to this fact, however, in considering which element is preponderant in our fauna, particularly since for more than one-third of these commoner species the range is not known with any degree of completeness.

VI. ISOPODA.

This order is represented in the local fauna by 25 or more species, of which 10 were recorded from our dredging stations and at least 7 more were taken by collectors from the laboratory during the progress of the Survey. One of these (*Erichsonella attenuata*) is here recorded for the first time for this region.

Our knowledge of this group in New England waters is due chiefly to the labors of O. Harger and Dr. Harriet Richardson. To the latter authority we are indebted for the identification of some of our earlier specimens, though the greater part of the material was determined by Dr. Osburn. The nomenclature employed by Miss Richardson has been adopted by us without modification.

Twenty-one species of isopods were listed by Harger in the "Invertebrate Animals of Vineyard Sound," of which only a small proportion were at that time recorded for definitely stated points within the limits of the region. In a later paper (1880) the group was treated much more fully by this writer.

The Canadian list of Whiteaves records about the same number of isopods (26) as have been listed for Woods Hole. Of these, nearly half (12) are common to the two lists. A somewhat greater number (30) is comprised in the Plymouth list, of which only 5 appear to be common to our local fauna. Twenty-four species have been recorded by Herdman for the Irish Sea, while Graeffe lists 51 species, some of which, however, are terrestrial.

The representation of this order in our dredgings is very slight. The figure representing the average number of species per dredge haul is only 0.4, while not a single species was taken with sufficient frequency to occur at one-fourth or more of the stations. The species having the widest occurrence was *Idothea phosphorea*, which was taken at 72 of the regular stations.

Only four species of this order were dredged by us with any frequency, and one of these (*Idothea baltica*) probably finds its more proper habitat among rockweed and eelgrass, whether growing alongshore or floating at the surface. It is thus possible that all of the specimens which were dredged by us actually came from floating material of this sort.[a]

One of the other species, *Leptochelia savignyi* was only taken at 11 stations, and these were all inshore stations of the *Phalarope* series. The species is abundant among floating weed, upon piles, etc., and probably does not belong to our deeper water fauna.

The two remaining species (*Idothea phosphorea* and *Erichsonella filiformis*) appear with considerable frequency in our dredging records. Of these the latter appears to be of pretty general distribution, occurring with nearly the same relative frequency in the Bay and the Sound, while the former is in a large degree restricted to the Sound, appearing in the Bay records only from stations near the lower end, in the vicinity of land.[b]

Isopods dredged by the Survey.

*Leptochelia savignyi (chart 103).
Cirolana concharum.
Chiridotea cæca.
Idothea metallica.
*Idothea baltica (chart 104).
*Idothea phosphorea (chart 105).
Edotea acuta.
Edotea montosa.
*Erichsonella filiformis (chart 106).
Stegophryxus hyptius.

Of the four commoner species, one (*Idothea phosphorea*) may be regarded as predominantly northern, having a range upon our coast which is stated by Miss Richardson as "coast of New England to Halifax, Nova Scotia, and the Gulf of St. Lawrence."

Two of the species may be regarded as predominantly southern, as follows:

Leptochelia savignyi .....Provincetown, Mass., to southern New Jersey (England to Senegal).
Erichsonella filiformis.....Nantucket Sound to Florida and the Bahamas.

One of the species (*Idothea baltica*) may be regarded as cosmopolitan, having been recorded from points as widely removed as Java and the Baltic Sea. On our coast it is said to range "from Nova Scotia and Gulf of St. Lawrence to North Carolina."

[a] Miss Richardson gives the bathymetric range of this species as "surface to 119 fathoms."
[b] Our 1909 dredgings confirm these statements as to both species.

VII. SCHIZOPODA, CUMACEA, STOMATOPODA.

Little attention has been given to the local representatives of the first of these groups since the work of S. I. Smith in 1879. The majority of the determined species of Schizopoda in our list are included solely upon the authority of Prof. Smith and of Miss Rathbun. Schizopods teem in the local plankton at certain seasons of the year, and specimens are occasionally taken in the dredge, though it is not at all certain that such specimens are actually brought up from the bottom. Only one species from our dredging collections (*Nyctiphanes norvegica*) has been definitely identified, since we have unfortunately been unable to find anyone who would undertake the task of determining our local Schizopoda. It will be seen that this order has a greater representation in each of the foreign lists which have been summarized in our comparative table. In the Plymouth list, indeed, the number is nearly five times as great.

Members of the order Cumacea are rather common in the Woods Hole plankton, and have occasionally been met with during the dredging. Dr. W. T. Calman (1912) has recently prepared a report upon the Cumacea of the U. S. National Museum. Eight of these species are recorded from definite points within the Woods Hole Region, two of them, indeed, being described from specimens obtained locally. One determined species (*Leptocuma minor*) was taken during the Survey dredging.

The Stomatopoda are represented in our waters by three species, of which only one (the common "Squilla") is at all familiar. None of these species occur, however, in the dredging records.

VIII. DECAPODA.

This group, comprising the largest and most familiar of our Crustacea, is represented locally by 55 species, including four which are listed doubtfully. These are assignable to 20 families and 37(+2?) genera. Of the total number of species listed by us, 27(+2?), or almost exactly one-half, were taken during the survey dredging. Many others were collected by our parties along shore, upon gulfweed, or elsewhere, while a few are recorded wholly on the authority of previous writers. Several of the species (*Portunus ordwayi*, *Arcnæus cribrarius*, *Palæmon tenuicornis*, and perhaps *Dissodactylus mellitæ*) had not, so far as we know, been previously listed for the shores of New England.

The published sources of information respecting the occurrence of this group are many. The chief contributors, so far as our New England species are concerned, have been S. I. Smith and M. J. Rathbun.

Smith, in the "Report upon the Invertebrate Animals of Vineyard Sound," listed 36 species of decapods, of which not over a third were definitely recorded for specified points within the region, while at least 5 were extralimital.

In her "List of the Crustacea" ("Fauna of New England" series), Miss Rathbun has included all but four of the decapods comprised in our own list, together with many others which are peculiar to more northern waters.

Whiteaves lists 34 decapods for the waters of eastern Canada, of which 12 are common to the Woods Hole region. The Plymouth catalogue contains 71 representatives of this order, of which only 3 appear to be common to our Woods Hole fauna. Herdman lists 61 decapods for the Irish Sea, while 73 are comprised in Graeffe's catalogue for the Gulf of Trieste.

Most of the decapods collected by us, being of large size and having rather obvious specific distinctions, were listed with full confidence in the field. The others were, for the most part, referred to Miss M. J. Rathbun, to whom we are likewise indebted for criticizing our check-list of local decapods and for information generously given throughout the progress of this work. To Dr. R. P. Bigelow we are indebted for the identification of a number of specimens collected during the first season of the dredging work.

Errors due to the confusion of one species with another in our dredging records are probably negligible in extent, excepting, perhaps, such as may relate to the small crabs of *Panopeus* group (now split into several genera). Upon this point the reader is referred to the statements made under the head of *Eurypanopeus depressus*, *Neopanope texana sayi*, and *Hexapanopeus angustifrons* in the annotated list. It seems possible that specimens identified by the collectors as "*Panopeus sayi*" were in some cases referable to one of the other species. It is probable, however, that the great majority of these crabs actually belong to the species last named, since none of the others are comparable with it in respect to frequency of occurrence. The examination of a large number of our specimens by Miss Rathbun indicates that *Eurypanopeus depressus* is at present comparatively rare in these waters, being by no means the common species which one would infer it to be from the statements of Smith.

The average number of species of decapods recorded by us from the 458 regular stations of the Survey is 3.5 per dredge haul. By far the most prevalent single species was *Pagurus longicarpus*, which was recorded from 290, or over 60 per cent, of the stations. Those species which were dredged at one-fourth or more of the total number of stations (arranged in order of frequency) are:

	Number of stations.
Pagurus longicarpus	290
Cancer irroratus	209
Pagurus annulipes	196
Libinia emarginata	192
Crago septemspinosus	169
Neopanope texana sayi	143

For the various groups of dredging stations and for the various types of bottom the averages are surprisingly uniform. The following figures are taken from the tables on pages 78 and 79:

Vineyard Sound:	
Fish Hawk	3.8
Phalarope	3.2
Buzzards Bay:	
Fish Hawk	3.4
Phalarope	3.2
Type of bottom:	
Sand	3.5
Stones and gravel	3.5
Mud	3.6

The lists of "prevalent" species for these different groups of stations are likewise surprisingly uniform in respect to the species comprised. Of the 6 species listed for one-fourth or more of the total number of stations, 3 appear in all seven of the lists of "prevalent" species; 2 others appear in all but one of these lists, while the remaining species appears in five of the seven lists. The lists of "prevalent" species for the three types of bottom comprise 5 species each. Of these, 4 are common to all three lists.

Of the 13 species for which distribution charts have been presented, 8 are of more or less general occurrence throughout the Sound and the Bay, so that their distribution bears little apparent relation to the character of the bottom. For this reason no such sharp division between Bay-dwelling and Sound-dwelling species can be made here, as was possible, for example, with the Annulata. The species whose distribution is most clearly determined by the nature of the bottom is the "lady crab," *Ovalipes ocellatus*. It will be seen from the chart that this crab is for the most part restricted to the western half of Vineyard Sound, where the bottom is known to consist for the most part of clear sand. That this peculiarity in the distribution of *Ovalipes* is related to the character of the bottom is shown by the fact that it was dredged by us several times near the head of Buzzards Bay, i. e., in the warmest waters of the region, while it is a matter of common knowledge that this species frequents sandy bottoms in shallow water.

Other species which appear upon the chart as restricted wholly or chiefly to Vineyard Sound are *Pinnotheres maculatus*, *Cancer borealis*, *Pelia mutica*, and *Pagurus acadianus*. The first of these is commensal in the mussels, *Modiolus modiolus* and *Mytilus edulis* and in the common scallop, *Pecten gibbus*. The distribution is thus dependent upon that of the hosts. The most frequent host, *Modiolus modiolus*, was, however, very scarce in Buzzards Bay, while *Mytilus* was found living only near the lower end. The occurrence of this species in the dredging records is likewise dependent, of course, upon whether or not the mussels from a given station were opened and examined for the crabs. This was probably done more commonly in Vineyard Sound than in Buzzards Bay. *Pinnotheres* has been taken by us at two supplementary stations in the Bay, on one occasion in *Pecten*, on the other in *Modiolus*.

Cancer borealis was recorded from only one regular station in the Bay,[a] and its occurrence there is certainly infrequent. It is most common at the western end of Vineyard Sound, though taken sparingly throughout its length. The absence of this species from the Bay is probably due in part, at least, to the temperature factor.

Pelia mutica is much less common in the Bay than in the Sound, and its occurrence in the former is restricted mainly to the inshore stations. The distribution of this species displays certain other peculiarities which will be discussed under the head of temperature.

Pagurus acadianus was not recorded once from the Bay, nor indeed was it recorded from the eastern half of Vineyard Sound. Here, too, temperature rather than bottom seems to be the determining factor.

As is well known, the distribution of many of the littoral species of decapods is conditioned by the character of the shore. Certain forms (e. g., the fiddler crabs) are chiefly confined to muddy situations; others (*Palæmonetes vulgaris* and *Hippolyte zostericola*) are found mainly in the beds of eel grass, while the common "*Hippa*" burrows in the sand at low-tide mark, etc. It is therefore rather surprising to find how few of the deeper water species are distributed in accordance with the character of the bottom.

Much more striking, on the other hand, are the examples of distribution in accordance with temperature. While many of our species display no restriction whatever in relation to this factor, certain others are pretty definitely limited to the colder waters of the region, while others still appear to avoid these colder waters, although elsewhere

[a] Later at two supplementary stations near the lower end.

of general distribution. These types will be considered separately. The ranges here stated have been furnished by Miss Rathbun.

Species found predominantly in the colder waters.

Pagurus acadianus.....From the Grand Bank of Newfoundland to the mouth of Chesapeake Bay.
Cancer borealis.....Nova Scotia to deep water off South Carolina.

Considering the range in latitude alone, it is questionable whether we may fairly assign either of these species to the "northern" group. In both cases, however, it is possible that their occurrence in southern waters is restricted to considerable depths.

Two other species (not plotted) which were taken by us only at the open ends of Vineyard Sound and Buzzards Bay and at Crab Ledge are *Hyas coarctatus* and *Pandalus leptocerus*. These may, perhaps, be regarded as predominantly northern species, though they are recorded (depth not stated) for points far to the southward on our coast.

Species which seem to avoid the colder waters, though elsewhere of general occurrence.

Pagurus annulipes.....Nantucket Sound to Indian River, Fla.
Pelia mutica.....Vineyard Sound to West Florida.
Neopanope texana sayi.....Provincetown to East Florida.

Another species, *Pagurus pollicaris*, might perhaps be added to this list. This hermit crab, it will be seen, was not recorded from the stations at the extreme western end of Vineyard Sound, though elsewhere prevalent. The case is not so striking, however, as those mentioned previously. The range of this latter species is said to extend from Cape Cod Bay to South Carolina.

None of these four species are recorded by us from Crab Ledge. All show, or appear to show, an avoidance of the coldest waters of Vineyard Sound, and all are predominantly southern in their distribution upon our coast. It seems quite likely, therefore, that temperature has been the factor responsible for the peculiarities in their local distribution.

Mention may appropriately be made here of certain species from southern waters which do not properly belong to our local fauna at all. Among these are four crabs (*Planes minutus*, *Portunus sayi*, *Portunus ordwayi*, and *Arenæus cribrarius*) and two shrimps (*Penæus brasiliensis* and *Latreutes ensiferus*). In nearly all cases these species have been found upon the floating gulfweed (*Sargassum bacciferum*), which is the home of so many waifs from the far south.

On the other hand, several shrimps of the genus *Spirontocaris*, which are known to be representatives of a northern fauna, have only been taken from the outlying colder waters of the region.

Very few species among those dredged by us showed any evident restrictions as to depth. This statement does not hold, however, for *Ovalipes ocellatus*, *Cancer borealis*, and *Pagurus acadianus*. All of these were dredged most frequently at depths of 10 fathoms or more, despite the comparatively small number of dredging stations at which such depths were recorded. *Ovalipes*, as we have seen, is by no means to be regarded as a deep-water crab, since it is known to be common on sand flats in shallow water. The greater average depth of the stations from which it was recorded results from its

prevalence in the middle of the Sound near the western end. The bottom here is largely of clean sand and many typical sand-dwelling species, such as *Echinarachnius parma* and various flounders, consequently flourish in this area. *Cancer borealis* and *Pagurus acadianus*, on the other hand, are probably limited to the deeper waters on account of the lower temperatures prevalent there. The latter species was taken only four times by the *Phalarope*, though dredged at 41 of the *Fish Hawk* stations in Vineyard Sound.

Among our local decapods we find a number of cases where interesting differences of habitat are displayed by the various species within a genus. Only a few such may be mentioned here. The differences in habitat shown by the two local members of the genus *Cancer* have already been referred to. These differences seem to relate to temperature, depth (if this is really an independent factor), and perhaps to character of bottom. One *Libinia* (*L. emarginata*) is of almost universal occurrence throughout both the Bay and the Sound; the other (*L. dubia*) appears to be restricted to shallow, inclosed waters. Although it is known to be abundant at some of these points, we do not have a single authentic record of its occurrence in the dredgings.[a] The difference displayed by the various local representatives of the genus *Pagurus* have likewise been discussed in another connection. The almost complementary character of the distribution patterns for *P. acadianus* and *P. annulipes* is especially to be noted.

The following decapods were taken with the dredge during the operations of the Survey. The asterisk, as usual, denotes species which were recorded from 10 or more dredging stations. For all of these, charts have been plotted.

Pandalus montagui.
Pandalus leptocerus.
Hippolyte zostericola.
Spirontocaris grœnlandica.
Spirontocaris pusiola.
*Crago septemspinosus (chart 107).
*Homarus americanus (chart 108).
Callianassa stimpsoni.
*Pagurus pollicaris (chart 109).
*Pagurus acadianus (chart 110).
*Pagurus longicarpus (chart 111).
Pagurus kroyeri.
*Pagurus annulipes (chart 112).
Heterocrypta granulata.
Hyas coarctatus.
*Pelia mutica (chart 113).
*Libinia emarginata (chart 114).
?Libinia dubia (very young).
*Cancer irroratus (chart 115).
*Cancer borealis (chart 116).
?Callinectes sapidus (fragment).
*Ovalipes ocellatus (chart 117).
Panopeus herbstii.
*Neopanope texana sayi (chart 118).
Hexapanopeus angustifrons.
*Pinnotheres maculatus (chart 119).
Pinnixa chætopterana.
Pinnixa sayana.
Dissodactylus mellitæ.

Grouping, as usual, the more prevalent species according to the extent of their known range upon our coast,[b] we have—

Predominantly northern forms.

Homarus americanus..... Labrador to New Jersey.
Pagurus acadianus..... Grand Bank of Newfoundland to the mouth of Chesapeake Bay. (Northern?).

[a] A few small specimens were thus identified at first, but further quite extensive collecting has thrown doubt upon these determinations.

[b] We are indebted to Miss Rathbun for these statements as to range.

Predominantly southern forms.

Pagurus pollicaris	Cape Cod Bay to South Carolina.
Pagurus longicarpus	Cape Ann, Mass., to Texas.
Pagurus annulipes	Nantucket Sound to Florida.
Pelia mutica	Vineyard Sound to West Florida.
Libinia emarginata	Casco Bay to West Florida.
Ovalipes ocellatus	Provincetown to the Gulf of Mexico.
Neopanope texana sayi	Provincetown to East Florida.
Pinnotheres maculatus	Cape Cod to Texas.

Of approximately equal range north and south.

Crago septemspinosus	East Florida; Arctic Alaska.
Cancer irroratus	Labrador to South Carolina.
Cancer borealis	From Nova Scotia to deep water off South Carolina.

Thus, as in the case of the Annulata and indeed of the majority of other groups, the commoner local Decapoda are predominantly southward ranging species, while only two of them are to be regarded as predominantly northern. Of these two, indeed, one is only doubtfully so classified, while both of them occur far to the southward of the Woods Hole region. The inclusion of various stragglers, both from the north and south, would, of course, increase both lists, but much the same proportions would probably be maintained.

IX. XIPHOSURA.

This order has been established to include the genus *Limulus*, a group of organisms having both crustacean and arachnidan affinities. *Limulus polyphemus*, our only American species, was very seldom taken during the survey dredgings, being primarily a shallow-water animal. With respect to its distribution, it is predominantly a southward-ranging form, occurring, according to Verrill, from Casco Bay to Florida. It has not been recorded for Canadian waters.

X. PYCNOGONIDA.

Of the sea spiders only 6 species appear in our catalogue, and of these 6 one is perhaps extralimital. Our knowledge of the New England species is due in large measure to the labors of E. B. Wilson, supplemented recently by the studies of L. J. Cole.

Only two of the species (*Tanystylum orbiculare* and *Anoplodactylus lentus*) appear with any frequency in the dredging records. The local distributions of these two species, so far as these are shown by our dredgings, are represented in charts 120 and 121. Both species are seen to be confined almost exclusively to Vineyard Sound, and both (particularly *Anoplodactylus*) appear to be restricted to the eastern half of the Sound. One might reasonably expect to find a more exact correlation between the distribution of these species and the distribution of the hydroids among which they live. But little correlation is to be observed, so far as our charts go.

The smaller and less conspicuous of these two pycnogonids (*Tanystylum orbiculare*) was probably frequently overlooked in listing the contents of the dredge, and it is likely, therefore, that this species is of more frequent occurrence than appears from our records. Its distribution, likewise, may be somewhat more general.

This class is represented in our list by a smaller number of species than have been recorded for any of the other stations considered in our comparative table.[a] To what

[a] Except Trieste, where apparently no record has been kept of the Pycnogonida.

degree this is due to the small number actually present in our local waters and to what degree it is due to an insufficient search can not be stated.

The ranges of our two commoner species, as stated by Wilson, are:

Tanystylum orbiculare.....From off Marthas Vineyard to Virginia.
Anoplodactylus lentus.....Long Island Sound; Woods Hole; Eastport, Me. (1 record). [a]

Thus the former appears to be a predominantly southern form, while for the latter the data are insufficient to warrant us in assigning to it a range.

One pycnogonid, which was taken upon the gulfweed on a number of occasions, is *Endeis spinosus* Montagu. This, like the gulfweed fauna in general, is doubtless an exotic species which comes to us from southern waters. Its presence on the weed is rather unexpected, considering the ordinary habitat of this species in European waters.

XI. INSECTA AND ARACHNIDA.

There are, of course, very few strictly marine insects in existence, and it is doubtful whether any of our local species can be so regarded. The thysanuran species *Anurida maritima* is, however, perhaps as nearly marine as are certain of our littoral Crustacea. Verrill and Smith record having taken in the vicinity of Woods Hole a number of insect larvæ, which appear to have been living in sea water. One of these was described by Packard as a new species. Most of the insects listed in that report were, however, beach-dwelling species, which seldom or never enter the water.

The list prepared by the writers comprises for the greater part species taken in brackish ponds in the neighborhood. Many of these were larvæ, and about half of them have not been determined specifically. In many, if not most, cases these insects are ones which are known to dwell in fresh-water ponds as well as brackish ones. It has been thought worth while to include them here, however, since no list has ever been published of our local brackish-water insects.

The single arachnid here listed (*Chernes oblongus*) is scarcely to be regarded as marine, though it has been taken under stones along shore, near low-water mark.

9. MOLLUSCA.

Mollusks, or their shells, have commonly constituted by far the most conspicuous feature of the organic contents of the dredge. In respect to the number of species likewise, the mollusks have generally preponderated, there frequently being more representatives of this group contained in a given dredge haul than of all the other phyla combined. Likewise the total number of molluscan species recorded in the course of our dredging operations is considerably greater than that of even the Crustacea, though the latter group preponderates as regards the number recorded for the region as a whole. It must be stated, however, that the vast majority of specimens taken were merely dead shells, and that many species were rarely or never taken in a living condition. This preponderance of molluscan remains in our dredging records is obviously due to the enduring character of the exoskeleton of these animals, which insures the accumulation of shells, even in the case of the less common species. Another fact which results directly from the one just mentioned is the relatively great frequency with which most of the molluscan species were dredged. Of the 127 species which appear in our dredging records, 68, or more than half, are recorded from more than 10 stations each, while

[a] This is to be regarded as a doubtful record.

23 of these mollusks appear in the list of species which were taken at one-fourth or more of the total number of stations. Thus exactly one-half of the latter list is constituted by Mollusca.

We regard our molluscan records as being, on the whole, relatively complete and comparatively free from error. The species are for the most part large and easy of identification. Fortunately for the collectors, systematic conchology is based largely upon shell characters, so that the determinations could commonly be made with a high degree of confidence in the field. The few cases among the larger species in which confusion was believed to be possible were early recognized, and we believe that errors respecting such forms were nearly always avoided except at the beginning of the work. Wherever doubt was felt, and especially in the case of the smaller species, specimens were preserved for identification by specialists. We were fortunate enough to have the assistance of such well-known authorities as Dr. W. H. Dall and Dr. Paul Bartsch in the identification of the less familiar species of shell-bearing mollusks. We are likewise indebted to Dr. Dall for the critical examination of our manuscript check list and for supplying us with the ranges of distribution which are given below. The classification and terminology adopted are his.[a] The nudibranch mollusks, on the other hand, including many specimens taken in the townet, as well as those which were dredged, were identified by Dr. F. M. MacFarland, of Stanford University, and Dr. MacFarland has likewise kindly revised that portion of the manuscript devoted to this group.

Certain sources of error have, notwithstanding, to be considered in the records for the Mollusca. Some of the minute forms representing the genera *Turbonilla*, *Odostomia*, *Cœcum*, *Cylichna*, etc., were doubtless frequently overlooked, as likewise such small species as *Astyris lunata*, *Lacuna puteola*, *Triforis nigrocinctus*, and *Bittium nigrum*. During the first season's work, especially when less thorough methods of sifting the bottom deposits were employed, it is likely that the records for these forms were much less complete than they were later. Again, the failure to use a canvas mud bag and the consequent escape of the finer components of the bottom material doubtless resulted in many cases in the loss of these small mollusks.

As already mentioned, it was found that during the rather experimental earlier work of the Survey certain forms having a close superficial resemblance had been confused with one another. Since it is believed that these ambiguities have in most cases been eliminated by special dredgings at the points in question, they can not seriously affect the value of our results. Some of the smaller species of *Natica* (*Polynices*) were, it is believed, wrongly identified in the field, and in such cases these records have been entered merely as "*Polynices* sp." Even *Polynices triseriata* was not during the first season always listed separately from *Polynices heros*, of which species it has often been regarded as a variety or even as an immature stage. In consequence of this the records for *P. heros* are doubtless somewhat fuller than they should be, those for *P. triseriata* being correspondingly curtailed.

In a few cases, notably with the small shells of the genus *Turbonilla*, confusion was brought about by our failure to recognize the presence of several species among the specimens taken. Instead of preserving samples of *Turbonilla* shells from every station at which they were encountered it frequently happened that the collectors chose speci-

[a] Except that we have retained the Amphineura in a separate class. Dr. Dall has recently expressed the belief that they constitute "at most an order."

mens from one of the dredge hauls, believing these all to be of one species and therefore regarding them as representative of the specimens taken from various other dredge hauls. Since an examination by Dr. Bartsch revealed the presence at times of three or four species of *Turbonilla* from a single dredging station, it is obvious that such records as are not based directly upon preserved material taken at one station are worthless so far as specific names go. It has been necessary, therefore, to record a large proportion of our Turbonillas merely as "*Turbonilla* sp.;" and thus our data for this interesting genus are in a large degree rendered valueless.

There are some other possible sources of error in interpreting our records which have no relation to defects of method. For example, for certain of the gastropods the apparent distribution is doubtless much more extensive than the actual one, owing to the transportation of their shells by hermit crabs. This is notably true of the introduced periwinkle, *Littorina litorea*, which is typically and indeed almost exclusively a littoral (intertidal) species. Nevertheless the shells of this mollusk were found at 131 stations, occurring even at depths of 10 or 15 fathoms. Other gastropods whose shells are most commonly occupied by the paguri are *Tritia trivittata*, *Anachis avara*, *Ilyanassa obsoleta*, *Polynices heros*, *P. triseriata*, *P. duplicata*, *Busycon canaliculatum*, *B. carica*, *Urosalpinx cinereus*, and *Eupleura caudata*. To what extent the distribution of these species, as plotted in the charts, has been the result of transportation by hermit crabs is impossible to state. It is not recorded in all instances whether or not a given shell was inhabited by one of the crabs, and in any case the presence of the latter in a shell would not by any means prove that this had been carried to any great distance beyond the point where the mollusk lived.

In the case of certain thin shells of light weight it is quite probable that the tidal currents have often been instrumental in carrying them beyond the original habitat of the animal, though we can not, of course, assume this in any single case. Man, likewise, has almost certainly been responsible for the occurrence of the shells of one species, at least, in unexpected localities. The large oyster shells which have been taken not infrequently in various parts of the main channel of Vineyard Sound have probably been cast overboard from passing vessels, since living oysters of our American species are not known to occur in such situations.

In the charts for the Mollusca, as for other shell-bearing organisms, we have indicated the known presence of living specimens at a given station by means of a circle surrounding the star. It must not be inferred, however, that only dead specimens were taken at the other stations. Absence of the circle denotes either that the occurrence of shells only was specified or merely that living specimens were not recorded.[a] It is quite certain that living mollusks were of much more frequent occurrence in our dredge hauls than the circles upon the distribution charts would imply. This is probably particularly true of the small gastropods. Indeed, the chiton *Chætopleura apiculata*, which was seldom taken except alive, was not commonly designated as living or dead in the dredging records. For this reason, it has been necessary to omit the circles from the chart.

For the remainder of this discussion it will be best to consider the classes of Mollusca separately.

[a] For certain mollusks we have employed the circle whenever the nature of the record rendered it probable that living specimens were taken, even though this was not expressly stated. For example, the note "on [or in] hermit crab shells," when applied to *Crepidula*, has been regarded as equivalent to a record of living specimens.

I. PELECYPODA.

Of the bivalve mollusks 70 (+6?) species have been recorded belonging to 31 families and 48(+1?) genera. Of these, 57 species were taken during the Survey dredging and 6 of them were new to the region when first collected by us. So far as known no species new to science have been found.

Verrill and Smith in 1873 listed 84 species of lamellibranchs, of which, however, only 61 were recorded for specified points within the Woods Hole region, although the stated ranges of 12 others would render their occurrence here probable.

In subsequent papers Verrill added greatly to our knowledge of the north Atlantic Mollusca, but most of these later papers dealt chiefly with collections made in much deeper waters.

Before Verrill, Gould (1841, 1870) had catalogued the Mollusca of this state in his well-known "Report on the Invertebrata of Massachusetts." There were here included a large proportion of our Woods Hole species, though comparatively few definite records are offered by Gould relating to the occurrence of mollusks within our region.

It is worthy of note that, although our list of local Pelecypoda is probably fairly complete, it is considerably exceeded by that comprised in each of the other faunal catalogues which have been summarized in our comparative table. Thus the Canadian list contains 100 species, the list for Plymouth 86, that for the Irish Sea 108(+3?), and that for the Gulf of Trieste 107. Thus, even in those cases where the areas comprised are roughly comparable, the other regions exceed our own in the wealth of species. Of the 100 Canadian species 55 (=55 per cent of Canadian list, or about 75 per cent of our own) are common to the Woods Hole region. On the other hand only 5 of the 86 Plymouth species are known to be common to our own fauna.[a]

On an average 9.2 species of bivalve mollusks were taken per dredge haul at all of the 458 regular stations of the Survey. This figure is considerably larger than that representing any other class of organisms. The single species which was taken most frequently was *Arca transversa*, which was recorded from 264 of the stations. The following is a complete list of those species which were taken at one-fourth or more of our dredging stations, the species being arranged in order of frequency:

	Number of stations.
Arca transversa	264
Anomia simplex	256
Ensis directus	235
Clidiophora gouldiana	234
Spisula solidissima	222
Cardium pinnulatum	219
Mytilus edulis	217
Nucula proxima	205
Tellina tenera	193
Callocardia morrhuana	192
Crassinella mactracea	182
Pecten gibbus borealis	162
Corbula contracta	128
Modiolus modiolus	120

[a] As already pointed out, a careful study of synonymy might result in somewhat increasing this number.

A study of the distribution charts shows us that, whereas a considerable number of our local lamellibranchs are of very general distribution throughout Vineyard Sound and Buzzards Bay, a yet greater number show definite restrictions in relation either to the character of the bottom or to temperature. The part played by the bottom in determining the wealth of lamellibranch life is indicated to some extent in the figures representing the average number of species per dredge haul taken upon the three chief types of bottom. These are: Gravel and stones, 7.7; sand, 9.8; mud, 11.0.

These figures are quite in accord with those giving the average number of species per dredge haul in the Sound and the Bay:

Vineyard Sound:	
Fish Hawk	8.2
Phalarope	7.5
Buzzards Bay:	
Fish Hawk	11.5
Phalarope	11.6

It is not evident, however, why the *Phalarope* stations of the Bay, which, on the whole were decidedly less muddy than the *Fish Hawk* stations, should none the less show a larger number of species.

The lists of "prevalent" species for the three types of bottom (i. e., those present at one-fourth or more of the stations) display a degree of uniformity which was unexpected in view of the above shown differences in the wealth of species per dredge haul. The number of prevalent species (16) is the same for sandy as for muddy bottoms, while 13 such species are listed for bottoms of gravel and stones. Of these, 9 are common to the three lists.

Passing to a consideration of the charts (122–160) we find a considerable variety among the distribution patterns, but it seems possible to reduce these to comparatively few types. These last are not, however, to be distinguished sharply from one another.

Of general distribution.

Anomia simplex.
Pecten gibbus borealis (scarce, however, in center of Bay).
Arca transversa.
Nucula proxima.
Cardium pinnulatum.
Callocardia morrhuana.
Tellina tenera.
Ensis directus.
Clidiophora gouldiana.

General in the Sound; common in the Bay, but restricted to inshore stations.

Crassinella mactracea.
Divaricella quadrisulcata (only 20 stations altogether).
Cumingia tellinoides (not exactly general in Sound, and some records for middle of Bay).
Spisula solidissima (some records for middle of Bay).
Cochlodesma leanum.
Corbula contracta.

General in the Sound; in the Bay, restricted to lower half.

Mytilus edulis.
Astarte castanea.
Petricola pholadiformis.

Restricted wholly or chiefly to the Sound.

Anomia aculeata.
Pecten magellanicus.
Modiolus modiolus (a few inshore stations in Bay).
Crenella glandula.
Arca ponderosa.
Venericardia borealis.
Thracia conradi.

Restricted wholly or chiefly to the Bay.

Arca pexata.
Yoldia limatula.
Solemya velum (confined to inshore stations).
Lævicardium mortoni (most abundant at inshore stations).
Venus mercenaria.
Tagelus gibbus (confined to inshore stations).
Macoma tenta.
Mulinia lateralis.
Mya arenaria (confined to inshore stations).

It will be noted that even some of those species which are restricted to Buzzards Bay (*Solemya velum*, *Tagelus gibbus*, *Mya arenaria*) are found there only at the inshore stations. Another species which is, on the whole, restricted to these stations, both in the Bay and the Sound, is *Lyonsia hyalina*.

An analysis of our records shows that certain species appear to exhibit marked preferences as to the depth of the water which they occupy. The following, for example, are in considerable degree restricted to depths of 5 fathoms or less:

Pecten gibbus.
Arca pexata.
Solemya velum.
Tagelus gibbus.
Lyonsia hyalina.
Mya arenaria.

Four of these six species are those which have just been mentioned as restricted to the inshore stations.

Species which were dredged most frequently at depths of 10 fathoms or more[a] are:

Pecten magellanicus.
Modiolus modiolus.
Modiolaria nigra.
Crenella glandula.
Venericardia borealis.
Astarte undata.
Astarte castanea.
Cyclas islandica.
Thracia conradi.

With the exception of the two species of *Astarte*, all of those comprised in this last list will be found in the list of predominantly northern species given below. And, with the exception of *Astarte castanea* and *Modiolus modiolus*, all are more or less restricted to the colder portions of the Sound and the Bay.[b] Reference to the charts shows that the remaining seven species occur wholly or predominantly in the western half of Vineyard Sound and the lower end of Buzzards Bay. Five of these species (*Pecten magellanicus*, *Crenella glandula*, *Venericardia borealis*, *Astarte undata*, and *Cyclas islandica*) were likewise taken at Crab Ledge, where, as we have seen, many of our typical colder water

[a] Depths of 10 fathoms or more were recorded at only 36 per cent of the 458 stations. All these species were, nevertheless, dredged an absolutely greater number of times at such depths.

[b] As stated above (p. 28), the western half of Vineyard Sound is little if any deeper than the eastern half. The greater average depth at which these species occurred results from the fact that they were rarely taken near shore. Thus they figure but little in the *Phalarope* dredgings.

species are to be found. And six of them are comprised in the list of predominantly northern species given below.

Interesting comparisons between the distributions of different members of the same genus may be made for the genera *Anomia*, *Arca*, *Astarte*, and *Pecten*. The case of the two local species of *Astarte* is peculiar inasmuch as there is nothing in their ranges, so far as we know, which gives a clue to the differences which they display in their local distribution.

Certain species among the lamellibranchs dredged by us have never been taken in a living condition. Of these the most striking examples are *Arca ponderosa* and *Thracia conradi*. The former, indeed, has never been recorded living, so far as we know, north of Cape Hatteras, although fairly fresh shells have sometimes been found. It seems likely that both of these species may bury themselves too deeply in the bottom to be taken by the dredge.

Those species which were taken at 10 or more dredging stations have, as usual, been grouped, so far as possible, into predominantly northern and predominantly southern forms. The ranges given for the Pelecypoda and for the mollusks in general are those stated by Dall.[a]

Predominantly northern (13).

Anomia aculeata (chart 124)....Arctic Ocean to Cape Fear.
Pecten magellanicus (chart 125).Labrador to Cape Hatteras.
Mytilus edulis (chart 127).....Arctic Sea to North Carolina.
Modiolus modiolus (chart 128)..Arctic Sea to North Carolina (Florida?).
Modiolaria nigra (chart 129).....Arctic Sea to Cape Hatteras.
Crenella glandula (chart 130)...Arctic Sea to Cape Hatteras.
Nucula proxima (var. trunculus Dall) (chart 134).....Nova Scotia to New York.
Yoldia limatula (chart 135).....Arctic Ocean to North Carolina.
Venericardia borealis (chart 137) Hudson Strait to off Hatteras.
Cardium pinnulatum (chart 142) Labrador to Cape Lookout.
Cyclas islandica (chart 144)....Arctic Ocean to Cape Hatteras (at latter point in deep water only).
Spisula solidissima (chart 153)..Labrador to Cape Hatteras.
Thracia conradi (chart 155).....Labrador to Cape Hatteras.

Predominantly southern (19).

Ostrea virginica (chart 122)....Prince Edward Island to West Indies.
Anomia simplex (chart 123)....Cape Sable to Martinique.
Pecten gibbus borealis (chart 126).....Nova Scotia to Tampa, Fla.
Arca ponderosa (chart 131).....Provincetown to Yucatan.
Arca transversa (chart 132).....Cape Cod to Mexico.
Arca campechiensis pexata (chart 133).....Cape Cod to Texas.
Crassinella mactracea (chart 140).....Cape Cod to Florida.
Divaricella quadrisulcata(chart 141).....Cape Hatteras to Brazil. (Woods Hole region.)
Lævicardium mortoni(chart 143) Nova Scotia to Venezuela.
Venus mercenaria (chart 145)...Nova Scotia to Yucatan.

[a] Dr. Dall has kindly furnished us with some unpublished notes, which modify to some degree the ranges as stated in his "Preliminary Catalogue of the Shell-bearing Marine Mollusks."

Callocardia morrhuana (chart 146).....Prince Edward Island to Florida.
Petricola pholadiformis (chart 147).....Prince Edward Island to Nicaragua.
Tagelus gibbus (chart 148).....Cape Cod to Brazil.
Tellina tenera (chart 149).....Prince Edward Island to Barbados.
Macoma tenta (chart 150).....Cape Cod to Haiti.
Cumingia tellinoides (chart 152) Cape Cod to south Florida.
Mulinia lateralis (chart 154)....New Brunswick to Texas.
Lyonsia hyalina (chart 157)....Nova Scotia to Texas.
Corbula contracta (chart 159)...Cape Cod to Jamaica.

Of approximately equal range north and south (7).

Solemya velum (chart 136).....Nova Scotia to North Carolina.
Astarte undata (chart 138).....Gulf of St. Lawrence to Cape Hatteras.
Astarte castanea (chart 139)....Nova Scotia to New Jersey and off Hatteras (deep).
Ensis directus (chart 151).....Labrador to Texas.
Cochlodesma leanum (chart 156) Nova Scotia to Hatteras.
Clidiophora gouldiana (chart 158).....Nova Scotia to New Jersey (North Carolina?).
Mya arenaria (chart 160).....Arctic Sea to Miami, Fla.

It will be seen that exactly one-third of these species have been listed as predominantly northern, while very nearly one-half are to be regarded as southern. The seven remaining species are not assignable to either division.

The following species are recorded from our dredgings, but were not taken frequently enough to warrant us in plotting their distributions:

Pecten islandicus.
Modiolus demissus.
Modiolaria lævigata.
Nucula delphinodonta.
Astarte quadrans.
Aligena elevata.
Phacoides filosus.
Cardium ciliatum.
Gemma gemma.
Tellina tenella.
Siliqua costata.
Thracia septentrionalis.
Periploma papyracea.
Saxicava arctica.
Cyrtodaria siliqua.
Pholas costata.
Zirphæa crispata.
Teredo navalis.

Most of these species appear to be actually rare within the region. Several of them, on the contrary (*Modiolus demissus, Gemma gemma, Teredo navalis*) are extremely abundant in their proper habitats, though rarely taken with the dredge.

II. AMPHINEURA.

Of the Amphineura, or chitons, only two species are found in this region. One of these, *Trachydermon ruber*, is quite rare locally. We have met with it but twice in dredging, only a single specimen having been taken on each occasion. Both were found near the lower end of Buzzards Bay. This species is essentially a northern one, being said to range from the Arctic Sea to New York. The other, *Chætopleura apiculata*, is scattered pretty generally throughout the eastern half of Vineyard Sound and along the shores of Buzzards Bay (chart 161). Its scarcity in the western portion of the Sound and its apparent absence from the deeper waters of the Bay are perhaps due chiefly to the character of the bottom. As is well known, the chitons adhere to solid objects, such

as stones and shells.[a] On the other hand, it is not improbable that the temperature factor has been partly responsible for the distribution of *Chætopleura* in Vineyard Sound, as in the case of a number of other southern species which appear to avoid the colder waters of the region. Like those which have previously been discussed, *Chætopleura* was not recorded by us from Crab Ledge. The range of this species, as stated by Dall, extends from Cape Cod to Haiti. Our region thus lies at or near its northernmost limit of distribution.

III. GASTROPODA.

Of the Gastropoda we have recorded 123 determined species, together with 10 which were doubtful or undetermined. Sixty-four (+2?) of these species were encountered during our Survey dredgings, and at least 17 are believed to have been previously unrecorded for the region.

Verrill and Smith, in their Vineyard Sound report, listed 93 species, of which, however, only 65 were definitely recorded for specified points within the region, although the ranges of 20 more, as stated by them, would include the Woods Hole region. The completeness of Verrill's list, as regards our more familiar species, renders conspicuous two exceptions. One is our now abundant periwinkle, *Littorina litorea*, which did not reach Woods Hole in its southward migration until the year 1875; the other is *Lacuna puteola*, an allied species though quite a minute one, which is likewise very common here at the present time. Whether or not this latter mollusk is also a comparatively recent immigrant can not be stated. It has long been known in the British Isles.

In the case of the gastropods, as in that of the lamellibranchs, our list of species is greatly exceeded by all of the other faunal catalogues which have been summarized in our comparative table. The difference in favor of the Plymouth catalogue is due largely, if not wholly, to the inclusion of a greater number of nudibranchs. It is not unlikely that sufficient attention to our local nudibranchs on the part of a specialist would result in adding considerably to the number of species recorded for the region. As regards the shell-bearing species, however, we believe our list to be relatively complete for local waters.

The average number of species of gastropods taken per dredge haul for the 458 regular stations of the Survey was 6.8. This figure is only exceeded by that for the Pelecypoda.

Those species which were so common as to be recorded from one-fourth or more of our dredging stations are listed herewith in the order of frequency:

	Number of stations.
Tritia trivittata	373
Crepidula fornicata	326
Anachis avara	295
Crepidula plana	291
Astyris lunata	245
Polynices heros	165
Urosalpinx cinereus	156
Polynices triseriata	144
Littorina litorea (shells only)	131

[a] Its apparent scarcity, even upon the stony bottoms off the shores of Cuttyhunk and Gay Head, renders the alternative explanation more likelyf or these points.

As in the case of the lamellibranchs, the average number of gastropod species taken per dredge haul was considerably greater for Buzzards Bay than for Vineyard Sound. This statement applies equally to the *Fish Hawk* and the *Phalarope* stations. The average number for dredge hauls upon muddy bottoms (7.8) is likewise seen to exceed that for the other types of bottom, though the difference is much less pronounced than for the bivalve mollusks; while the figure for sandy bottoms (6.5) is seen to be practically the same as that for bottoms of gravel and stones (6.7). The difference, in this respect, between the two chief classes of mollusks is doubtless due to the fact that the Pelecypoda comprise a considerable proportion of burrowing forms.

Reference to the tables giving the "prevalent" species for each type of bottom shows that there are 8 such species recorded for sandy bottoms, 9 for gravelly and stony ones, and 11 for muddy ones. Of these, 7 species (or their shells, at least) are common to the three lists.

Charts 162 to 188 portray the distribution of most of those species which were recorded from 10 or more of our stations in Vineyard Sound and Buzzards Bay. The exceptions are *Natica pusilla*, for which no chart has been presented, owing to the ambiguity of many of the records (see p. 144), and certain species of *Turbonilla*, several of which were doubtless taken with considerable frequency. Owing to a confusion, already referred to, in our original records we have devoted a single chart to all the members of this genus, so far as recorded by us.

In respect to their distribution in local waters, we may group the gastropods in much the same way as has already been done for the pelecypods.

Of general distribution.

Busycon canaliculatum.
Tritia trivittata (commonest recorded species).
Anachis avara.
Urosalpinx cinereus (comparatively few in middle of Bay).
Turbonilla sp. sp.
Crepidula fornicata.
Crepidula plana.
Polynices duplicata.
Polynices triseriata.

General in Sound; in Bay mainly confined to inshore stations.

Astyris lunata.
Cerithiopsis emersonii (hardly general in Sound).
Vermicularia spirata (hardly general in Sound; mostly confined to eastern half).

Restricted mainly or wholly to Sound.

Buccinum undatum.
Crucibulum striatum.
Polynices heros.

Restricted mainly or wholly to Buzzards Bay.

Tornatina canaliculata.
Cylichnella oryza.
Busycon carica.
Ilyanassa obsoleta (mostly in upper half of Bay).
Eupleura caudata (in Sound, mainly near shore).
Bittium alternatum (adlittoral).
Cæcum cooperi (adlittoral).

The last two species (*Bittium alternatum* and *Cæcum cooperi*) were confined almost wholly to the inshore stations of the Bay. Two other species, *Lacuna puteola* and *Crepidula convexa*, while found alike in the Sound and the Bay, are restricted in both largely

to the inshore stations. The case of *Crepidula convexa* is peculiar, inasmuch as the two other local species of *Crepidula* are both of very general distribution. The distribution of this species is particularly unintelligible, in view of the fact that none of our hermit crabs, upon whose shells it finds lodgment, are in any degree restricted to the shallower waters along shore. Yet this mollusk was recorded from 45 of the *Phalarope* and *Blue Wing* stations, as compared with only 16 *Fish Hawk* stations; and of these last, indeed, there is reason for regarding a considerable number as doubtful. This species is known to be the commonest *Crepidula* upon the smaller hermit crabs in shallower waters near shore, but it is difficult to understand why this mollusk is not more frequently carried by its hosts into the deeper waters as well.

As in the case of the Pelecypoda, certain species of gastropods are restricted to the colder waters of the Sound. The only two to be mentioned are *Buccinum undatum* and *Crucibulum striatum*. The former was likewise taken at 6 of the 7 regular stations at Crab Ledge, and is known to be a predominantly northern species. Such is not true of *Crucibulum*, however, and we are at a loss to explain this peculiarity in its local distribution.

Both of these species (and these alone among the gastropods) were taken predominantly at depths of 10 fathoms or more. In fact *Crucibulum* was dredged only once by the *Phalarope*, and was never taken in less than 10 fathoms of water.

Certain species among those charted are seen to be less common, or to be wanting altogether, in the western half of the Sound, although present in the eastern half. Such are *Cerithiopsis emersonii* and *Vermicularia spirata*. Two others (*Eulima conoidea* and *Seila terebralis*) might also be mentioned here, though neither has been taken with sufficient frequency to warrant our drawing any general conclusions.

The distributions of two species of gastropods as portrayed upon our charts are obviously largely fictitious. We refer to *Littorina litorea* and *Ilyanassa obsoleta*, both of which are known to be restricted, when living, to the immediate vicinity of the shore. The broadcast way in which the shells of these species, particularly the former, are strewn around the local sea floor testifies strongly to the part played by hermit crabs in transporting them.

Several genera comprise species which display among themselves interesting differences of habitat. Such are *Busycon*, *Crepidula*, *Littorina*, and *Polynices*. For most of these the differences may readily be seen by reference to the charts. The case of *Crepidula* has just been discussed; that of *Polynices* receives some mention in chapter V (p. 186). As regards *Littorina*, only one species is represented upon our chart, and this latter in no way represents the distribution of the living animals. In the catalogue of species (section III), however, the differences in their respective habitats have been briefly indicated.

A glance at the subjoined lists shows that our local assemblage of gastropods, or at least the commonest and most representative among them, are even more dominantly southern than are the pelecypods. Of the 27 species there considered, 22 are to be regarded as southern, 3 as northern, while the remaining 2 are not to be assigned to either category.

Predominantly northern (3).

Buccinum undatum (chart 166).... Arctic Sea to Charleston Harbor.
Polynices heros (chart 187)..... Labrador to Virginia.
Polynices triseriata (chart 188)..... Labrador to off Hatteras.

Predominantly southern (22).

Tornatina canaliculata (chart 162)..Portland, Me., to Haiti.
Cylichnella oryza (chart 163).....Cape Cod to Charleston, S. C.
Busycon canaliculatum (chart 164)..Beverly, Mass., to Gulf of Mexico.
Busycon carica (chart 165).....Cape Cod to St. Thomas, West Indies.
Tritia trivittata (chart 167).....Nova Scotia to St. Augustine, Fla.
Ilyanassa obsoleta (chart 168).....Nova Scotia to Tampa, Fla.
Anachis avara (chart 169).....Casco Bay to Florida Keys.
Astyris lunata (chart 170).....Cape Ann to Brazil.
Eupleura caudata (chart 171).....Cape Cod to West Indies.
Urosalpinx cinereus (chart 172)....Prince Edward Island to St. Augustine, Fla.
Eulima conoidea (chart 173).....Hatteras to West Indies. (Woods Hole region.)
Seila terebralis (chart 175).....Massachusetts Bay to Haiti.
Cerithiopsis emersonii (chart 176)...Cape Cod to Grenada, West Indies.
Bittium alternatum (chart 177).....Prince Edward Island to Louisiana.
Cæcum cooperi (chart 178).....Cape Cod to Jamaica.
Vermicularia spirata (chart 179)....New England to Bahia, Brazil.
Crucibulum striatum (chart 182)...Nova Scotia to Florida Keys.
Crepidula fornicata (chart 183).....Prince Edward Island to New Granada.
Crepidula convexa (chart 184).....Nova Scotia to Florida; (Texas?).
Crepidula plana (chart 185).....Prince Edward Island to Bahia, Brazil.
Natica pusilla.....Eastport, Me., to Florida.
Polynices duplicata (chart 186)....Massachusetts Bay to Mexico.

Of approximately equal range, north and south.

Littorina litorea (chart 180).....Nova Scotia to Cape May, N. J.

Of doubtful position.

Lacuna puteola (chart 181).....Woods Hole region; Stonington, Conn.; England.

The following is a list of species which were recorded with relative infrequency (at less than 10 stations) during the dredging:

Cylichna alba.
Haminea solitaria.
Cratena pilata.
Coryphella mananensis.
Coryphella salmonacea.
Doto coronata.
Mangilia cerina.
Drillia sp.
Chrysodomus decemcostatus.
Tritonofusus islandicus.
Tritonofusus stimpsoni.
Arcularia vibex.
Thais lapillus.
Boreoscala grœnlandica.
Epitonium multistriatum.
Epitonium dallianum.
Epitonium lineatum.
Stilifer stimpsoni.
Turbonilla nivea.
Turbonilla vineæ.
Turbonilla elegantula.
Turbonilla arcolata.
Turbonilla interrupta.
Turbonilla winkleyi (this and probably several others were taken at more than 10 stations).
Turbonilla rathbuni.
Odostomia seminuda.
Odostomia trifida.
Triforis nigrocinctus.
Cæcum pulchellum.
Littorina rudis.
Lacuna vincta.
Rissoa arenaria.
Cingula minuta.
Polynices immaculata.
Velutina lævigata.
Velutina zonata.
Acmæa testudinalis.
Margarites obscurus.

Some of these species (*Thais lapillus*, *Littorina rudis*, *Lacuna vincta*, *Acmæa testudinalis*) are more or less common along shore, but rarely find their way into the dredge. A considerable number of the species were, on the other hand, only taken at Crab Ledge, and thus do not form any part of the fauna of Vineyard Sound or Buzzards Bay.

The group of pelagic gastropods known as the Pteropoda is represented locally by a few species which are occasionally found in the outlying waters of the region. Only one of these, *Cavolina tridentata*, has been met with in the dredge, a single shell having been taken near the western end of Vineyard Sound. Such a state of affairs is in striking contrast to the condition in some parts of the Atlantic Ocean, where the remains of this class of mollusks accumulate to such a degree as to form a veritable "pteropod ooze," covering wide tracts of the sea floor.

IV. CEPHALOPODA.

Two species of squid, *Loligo pealii* and *Ommastrephes illecebrosus*, are found in these waters. Only the former of these has been met with in dredging. *Loligo* has been frequently taken in the *Fish Hawk* dredgings throughout both the Sound and the Bay, being recorded from 73 stations (chart 189). It has never, however, been dredged by the *Phalarope*. This is doubtless due to the active movements of this animal, which would not be readily caught in a small dredge net, although it would be taken without difficulty by the beam trawl. The eggs of the squid, on the other hand, were brought up very frequently both by the *Fish Hawk* and the *Phalarope*. The range of this species, as stated by Dall, is from Penobscot Bay, Me., to South Carolina. It thus ranks among the predominantly southern species.

Shells of the little known *Spirula peronii* sometimes drift to the outer island shores, and one specimen of an octopus (*Parasira catenulata*) was taken many years ago in Vineyard Sound.

10. ADELOCHORDA.

One species of *Balanoglossus* (*B. aurantiacus* (Girard)) is common at various points along shore, where it burrows rather deeply into the sand or gravel. So far as we know, it has never been taken locally with the dredge.

11. TUNICATA.

Tunicates, particularly the compound forms, constitute a conspicuous feature of the fauna of some portions of our local sea bottom. Certain species likewise abound on piles and on eel grass and rockweed along shore, while one or more pelagic forms are occasionally abundant within the limits of our region. The total number recorded, however, is small, only 22 [a] determined species being included with certainty in our catalogue; together with about 10 which are unidentified or doubtful. Of these 14(+6?) were encountered during our dredging operations. The average number of species taken per dredge haul was only 1.1, though considerable clusters of *Styela partita*, associated with *Molgula manhattensis*, *Perophora viridis*, *Didemnum lutarium*, and perhaps other compound forms were at times brought up together. The form having the most general

[a] Throughout our records *Amaroucium pellucidum* and "*Amaroucium constellatum*" were listed separately and treated as independent species. Owing to the ready distinguishability of these two forms and their somewhat different habitats we have not thought it worth while to readjust our records and computations, despite Dr. Van Name's seeming demonstration of the specific identity of the two.

distribution was *Didemnum lutarium* Van Name, which was taken at 99 of the regular dredging stations; thus not a single species was taken with sufficient frequency to appear in the list of those recorded from one-fourth or more of the entire number of stations. Only eight species were taken at as many as 10 of the stations.

As in the case of some other groups, certain of the earlier identifications by the collectors in the field were made with a confidence which did not afterwards seem to us justified. During the later seasons, accordingly, we preserved for reference to specialists a much larger proportion of the specimens taken. The only instances of ambiguity in our records, which seem worth considering, relate to the species of *Amaroucium* and to *Molgula arenata*. The former were commonly identified in the field by means of a superficial examination. Subsequent information leads us to believe that such identifications were for the most part correct; since the commoner, at least, among our local species are in most cases readily distinguishable by obvious characters. The small, sand-covered solitary ascidians, taken in the western portion of Vineyard Sound, were at first referred by us to a single species, *Molgula arenata*. We were informed by Prof. Ritter, however, that another of our local species, *Eugyra glutinans*, is superficially very similar to the former, and that, in the case of preserved specimens, dissection is necessary in order to distinguish between the two. Both species have been determined by Prof. Ritter in the material submitted to him; so that we feel confident in listing both of them for the western part of Vineyard Sound. On the other hand, it is more than possible that some of our earlier records for "*Molgula arenata*" refer in reality to *Eugyra glutinans*, while some of those for the latter species depend upon an assumed specific identity between specimens which were hastily examined and others which had been authoritatively determined. In view of this uncertainty, it has been thought best to plot but a single chart for these two species, denoting by the stars of solid black those stations from which *Molgula arenata* was recorded, and by the open stars stations from which *Eugyra glutinans* was recorded.

It is thought likely that errors of omission have been relatively infrequent in our records, since few of the local species, so far as known, are minute or inconspicuous. It is not unlikely, however, that some of the smaller sand or mud covered solitary ascidians may have escaped us, and it is possible that certain less common species (e. g., of *Molgula*) have been confused with the more familiar ones and recorded along with the latter.

We are indebted to Prof. W. E. Ritter, of the University of California, for identifying a large number of the simple ascidians, and to Dr. W. G. Van Name, of New Haven, for identifying many of the compound forms. To these same authorities we are likewise indebted for criticizing the manuscript relating to each of these respective subdivisions, and we have adopted the classification and nomenclature advised by them. Prof. Ritter expresses himself as being skeptical regarding the identity of many of the Atlantic coast species, and some of his determinations have been made with no great confidence. In such cases the doubtful character of the identification has been indicated in the list. Dr. Van Name has felt himself justified in making two rather radical changes respecting the genera *Amaroucium* and *Leptoclinum* (*Didemnium*). (See faunal catalogue, p. 731–733).

To Prof. W. A. Herdman, of Liverpool University, we are indebted for suggestions and advice relative to this group during the later stages of the writing of this report.

Verrill and Smith (1873) listed 18 determined species of tunicates for local waters, together with two which were not definitely recorded for the region, and five others which were not specifically determined. A number of these ascidians had been recently described by Verrill himself from specimens taken in the vicinity of Woods Hole. The *Leptoclinum luteolum* of Verrill is not regarded by Dr. Van Name as specifically distinct from the *L. albidum* of the same author, which, contrary to the belief of Verrill, does not appear to occur within the limits of our region. The "*Ciona tenella*" of Stimpson and of Verrill is now regarded as identical with *C. intestinalis* (Linnæus), while the "*Salpa caboti*" of Desor, which appears in Verrill's list, is not believed to be distinct from the *Salpa democratica-mucronata* of Forskäl.[a]

Certain species listed by Verrill (*Molgula papillosa, M. pellucida, M. producta, Eugyra pilularis, Cynthia carnea, Glandula arenicola*) have not been recorded for local waters by any subsequent writers.[b] On the other hand, one species new to science (*Bostrichobranchus molguloides*) was described by Metcalf from specimens taken within recent years in Buzzards Bay. Another species (*Didemnum lutarium* Van Name) although abundant and familiar locally, was only recently described for the first time. This species had hitherto been confused with Verrill's *Leptoclinum albidum* (=*luteolum*), the true home of which is north of Cape Cod. The survey has encountered a number of species which have not previously been listed in any published report of the fauna of this region. Such are *Ascidia complanata, Eugyra glutinans*, and *Salpa zonaria-cordiformis;* also (doubtfully determined) *Molgula koreni, M. citrina*, and *M. pannosa.*

Twenty-eight species of Tunicata are recorded by Whiteaves for eastern Canada; 36 species are comprised in the Plymouth list; 45(+14?) for the Irish Sea; and 75 for the Gulf of Trieste. Ten of the Canadian species and 2 of the Plymouth species appear to be common to our Woods Hole fauna. In considering any such comparisons, however, it must be borne in mind that practically no papers have been published during the past 30 years which deal with the New England Tunicata.

Only eight charts (190–197) have been presented as illustrating the distribution of the bottom-dwelling ascidians of Vineyard Sound and Buzzards Bay. Of these, seven are each for a single species, while another is based upon the records for two species (*Molgula arenata* and *Eugyra glutinans*) concerning which some confusion exists (see p. 156).

Like most of the fixed organisms which have been discussed in the present report, the ascidians are of far less frequent occurrence in Buzzards Bay than in Vineyard Sound. Indeed, only two species, *Molgula manhattensis* and *Didemnum lutarium*, occur with any frequency in the Buzzards Bay dredgings. The following figures permit a comparison of the average number of species per dredge haul taken in the two bodies of water:

Vineyard Sound:	
Fish Hawk	1.3
Phalarope	1.6
Buzzards Bay:	
Fish Hawk	.4
Phalarope	.7

[a] Ritter.

[b] These are all contained in the list of molgulids having "very imperfect descriptions" in Herdman's "Revised Classification of the Tunicata" (Journ. Linnaean Soc., vol. XXIII, 1891, pp. 557–652).

Far in excess of any of these figures is that expressing the number of species taken at the seven Crab Ledge stations. This is 3.3 per dredge haul. Certain localities in Vineyard Sound, likewise, notably the area between the Middle Ground and the shores of Marthas Vineyard were especially rich in tunicates. For example, five species each were taken at stations 63 and 7525, while six species were taken at station 7751.

As in many previous cases which have been discussed by us, we believe that the well-known difference between the bottoms of Buzzards Bay and Vineyard Sound is chiefly responsible for this difference in the wealth of their ascidian faunas. This belief is strengthened by a consideration of the average number of species per dredge haul taken upon the three principal types of bottom which have been distinguished by us. The figures, according to this basis of classification, are as follows: Mud, 0.4; sand, 0.9; stones or gravel, 1.9. Moreover, as in many previous cases, some of the species which are absent elsewhere in the Bay have been taken near shore, where the mud of the central region largely gives place to sand, gravel, and stones. Such in particular are *Styela partita* and *Amaroucium pellucidum constellatum*.

As is well known, ascidians are dependent upon ciliary currents for the food and oxygen brought to them in the water. It is thus natural that bottoms of soft mud should not commonly offer them a congenial habitat, even though a suitable basis for attachment should be present.[a] The occurrence of stones, shells, and algæ, or other suitable bases of support is likewise an important factor in determining the distribution of most species, as is evident from a comparison of the abundance of ascidian life upon bottoms of stones and gravel with that upon bottoms of sand. Herein, also, probably lies the explanation of the scarcity of bottom-dwelling tunicates in the western half of Vineyard Sound.

Of the seven species[b] for which separate distribution charts have been plotted, all agree in being either wholly lacking in the western half of Vineyard Sound, or, if present there at all, in being confined to the inshore (adlittoral) stations. As has been already pointed out, this western area of Vineyard Sound (barring the inshore region) is characterized by the presence of sand, and by the comparative absence of stones and gravel. In the case of *Styela partita*, *Molgula manhattensis*, and *Perophora viridis*, it is possible that distribution is in some measure determined by that of certain algæ, since these species are very frequently attached to the latter. An inspection of the distribution charts for the algæ, however, shows few species, if any, whose distribution would satisfactorily account for that of the ascidians named.

On a number of previous occasions, we have shown the likelihood that temperature has been the factor chiefly concerned in excluding certain species from the western end of Vineyard Sound. Various predominantly southern species seem unable to thrive in the colder waters of the region, just as certain northern forms seem unable to thrive elsewhere. Now an inspection of the table below, giving the ranges of our commoner species of ascidians, shows that none of those listed are predominantly northward ranging forms, while four, on the other hand, are predominantly southward ranging forms, some of which, indeed, reach their northern limit in Cape Cod. Despite these facts, it seems to us unlikely that temperature has been the factor chiefly concerned in determining the

[a] Exception must be made in the case of those species occurring in deep-sea oozes, many of which are stalked. (Herdman).

[b] Two of these are not now regarded by Dr. Van Name as being specifically distinct, but for reasons stated above (p. 155, footnote) their distributions have been plotted separately.

scarcity of ascidians in this portion of Vineyard Sound, since several of the forms in question (*Didemnum* and all of the species of *Amaroucium*) are abundant in this cold water, on the stony bottoms close to shore,[a] and even on Devils Bridge, off Gay Head. On the other hand, *Molgula arenata* (chart 190), likewise a predominantly southward ranging form, as judged from known records, occurs chiefly in the western part of Vineyard Sound, where its congenial habitat, a sandy bottom, is more prevalent.[b]

It would thus seem probable that the temperature factor plays little or no part in determining the distribution of ascidians within the limits of our charts, the primary factor being the character of the bottom, either directly or in its effect upon the distribution of marine algæ.

In the outlying colder waters, however, where northern representatives of nearly every phylum have been met with, we have found a number of ascidians proper to the "Acadian" fauna. Such are *Halocynthia echinata*,[c] *Ascidia complanata*, and the *Boltenia* recorded in the annotated list, all of which species have been dredged by us at Crab Ledge.

An interesting difference of distribution in relation to depth is revealed by an analysis of the records for *Amaroucium pellucidum constellatum* and *A. stellatum*. The latter was dredged only once at a depth less than 5 fathoms, while in more than 60 per cent of the cases it was taken at depths of 10 fathoms or more.[d] *A. constellatum*, on the other hand, was recorded 15 times from depths less than 5 fathoms, while in over 60 per cent of the cases it was taken at depths under 10 fathoms. This form is likewise known to occur upon piles, etc., in shallow water, while we have not observed *A. stellatum* in such situations.

The following list comprises all those species which were recorded in our dredging. The asterisk has the usual significance.

? Molgula citrina.
? Molgula koreni.
* Molgula manhattensis (chart 191).
? Molgula pannosa.
* Molgula arenata (chart 190).
Eugyra glutinans (chart 190).
Halocynthia echinata.
Boltenia sp.
* Styela partita (chart 192).
Styela sp. (Perhaps new.—Ritter).
Ascidia complanata.
Botryllus schlosseri.
* Perophora viridis (chart 193).
* Didemnum lutarium (chart 194).
Aplidium pallidum.[e]
* Amaroucium pelludicum[e] (chart 195).
* Amaroucium pelludicum constellatum[e] (chart 196).
Amaroucium glabrum.[e]
* Amaroucium stellatum[e] (chart 197).
Amaroucium sp. (Perhaps new.—Ritter).

The ranges here stated for the eight commoner species are given for the most part on the authority of Verrill (1873) and of Van Name (1910). The statements of the latter author have been followed for the compound forms, but for the simple ones no data later than those offered by Verrill appear to be available.

[a] It is true that the summer temperature of these shoal inshore waters is somewhat higher than that of the deeper waters in the middle of the channel.

[b] *Eugyra glutinans*, another sand-dwelling species occurring in this same region, is however, a predominantly northern form.

[c] This was likewise taken at Sankaty Head and once in Vineyard Sound.

[d] This notwithstanding the fact that depths as great as this were encountered at only 36 per cent of the stations.

[e] These five species are among those listed by Herdman as "unrecognizable Polyclinidæ." However imperfect the original descriptions may have been, these names none the less refer to well-known and readily distinguishable members of our local fauna.

Predominantly southern.

Molgula manhattensis	Casco Bay to North Carolina.
Styela partita	Massachusetts Bay to North Carolina.
Perophora viridis	Vineyard Sound to Beaufort, N. C., and Bermuda.
A. pellucidum	Vineyard Sound to North Carolina.

Of uncertain position.

Molgula arenata	Long Island Sound to Nantucket.
Didemnum lutarium	New England coast south of Cape Cod.
Amaroucium stellatum	Vineyard Sound to North Carolina (?).
A. pellucidum constellatum	Isles of Shoals (?) and Gloucester to Cold Spring Harbor, Long Island.

Thus, according to the information at our disposal, four of these eight species are to be regarded as predominantly southern, while the remaining four have only been authentically recorded from a very limited section of the coast. Only three species are known to occur north of Cape Cod.

12. PISCES.

The group of fishes occupies a peculiar position in the present work. The total number of species listed for this region is greater than that for any other group except the Crustacea. There are 247(+6 ?) species[a] representing 188(+2 ?) genera and 99 families. Only a very small proportion of these (30 species) have, however, been taken in the dredge, owing, first, to the fact that the great majority of the species do not ordinarily lie upon the bottom, and, secondly, to the fact that even the largest dredges and trawls which were employed were not well adapted to retaining active fishes. In general, we may say that this Survey has dealt only incidentally with the fishes, since the latter do not, for the most part, belong to the benthos, any more than do the Medusæ and free-swimming Crustacea. Our knowledge of the distribution of fishes within the narrow limits of such a small body of water, and of the causes determining this distribution, could be substantially increased only by the use of quite other implements than the dredge. As regards the catalogue, on the other hand, it seems likely that the list of local fishes as a whole is more complete than that of any other extensive group of organisms. And even our dredging has resulted in the capture of one fish which was not previously known south of Cape Cod. This was the little blennioid species, *Ulvaria subbifurcata.*

For the past 40 years Mr. Vinal Edwards, throughout the year, and various naturalists, during the summer months, have been engaged in an active search for new fishes. To the extraordinary zeal of Mr. Edwards and his rare power of observing small differences and recognizing unusual species has been due, in large measure, the completeness of our knowledge of local fishes. As early as 1873 Prof. Baird published a list of Woods Hole fishes, some of which had already been recorded for local waters by Storer many years before. This list has received continual additions from year to year in various publications of the United States Fish Commission. In 1898, Dr. H. M. Smith brought together all the previously published records relating to local fishes together with a large number of additional ones, and prepared the most complete list

[a] Two species of marsipobranchii have been included with the true fishes in this computation.

thus far presented. This contained over 200 species of marine fishes. In several supplementary lists and special notes Dr. Smith has amplified this catalogue.[a]

In 1908 Kendall published a "List of the Pisces" for the "Fauna of New England," series of the Boston Society of Natural History, but few changes or additions were made as regards the fishes of the vicinity of Woods Hole. All this material, together with many new data and a few entirely new records for species, have been summarized in the annotated list included in the present report.[b] In the preparation of the latter considerable collections of unpublished notes by Mr. Edwards were examined, and he himself was continually questioned throughout the progress of the work. The data contributed by Mr. Edwards were based (1) on records from the fish traps operated by the Bureau of Fisheries in the neighborhood of the Woods Hole station; (2) on records from the fyke nets, which have been set during the fall, winter, and spring in both the harbors of Woods Hole; (3) on the records of innumerable seining trips made at various times of the year, but particularly in the summer months; (4) the collections made by the tow net suspended from the end of the pier (furnishing records of the occurrence of young fishes); and (5) from specimens or information received from fishermen throughout all of the local waters. Most of the specimens collected during the dredging operations, and many more which were caught in other ways during this period, were identified by the authors of this report. Those concerning which any doubt was felt were referred to the ichthyologists of the Bureau of Fisheries. To Dr. H. M. Smith and Dr. W. C. Kendall we are indebted for a critical examination of our check list of fishes.

In our list of species are comprised 2 Marsipobranchii, 26 Selachii, and 219(+4?) Teleostomi. In our comparative table (p. 89) it will be seen that the fishes have been included in only two of the other faunal catalogues therein considered. Herdman records 134 species for the Irish Sea, i. e., hardly more than half the number comprised in our own catalogue, while Graeffe lists 181 species for the Gulf of Trieste. Here, as elsewhere, it would be interesting to know how largely these differences in the number of species are actual and how largely they are due to the thoroughness of the collecting and recording. It must be borne in mind that our own list comprises a large number of species which are not indigenous, being stragglers, whose presence in our waters is due to the proximity of the Gulf Stream. The number of such exotic species is probably peculiarly high in our region.

Owing to the small number of species taken by the dredge and to the comparative paucity of the records even for such as were taken, the data thus gained relating to the local distribution of these species have not been very impressive. In general we may say, however, that while some species appeared to have an unrestricted distribution in local waters, many more fishes were taken in Vineyard Sound than in Buzzards Bay; likewise that a number of species occurred wholly or mainly at the western end of the Sound.[c]

[a] See bibliographic list for the faunal catalogue, p. 791.

[b] The records of Cope (1870) for Newport have been included here, although they were not considered by Smith, who limited the "vicinity of Woods Hole" to a somewhat smaller area than the "Woods Hole Region" of the present report.

[c] It is likely that this latter fact is in a certain measure due to the greater frequency with which the beam trawl was employed upon the sandy bottoms at the western end of Vineyard Sound. This instrument was obviously better adapted to catching and retaining fishes than were the other types of dredge employed.

There is no evidence whatever for distribution in accordance with temperature within the narrow limits of the present region. Most of the species taken in the dredge are ones which have a more or less extended northerly as well as southerly range along the coast, and it so happens that *Pholis gunnelus*, the only strictly northern species which was dredged with any frequency, was taken at scattered stations throughout most of the Sound, but was not recorded from its western end. It is quite likely that the local distribution of this fish is limited by the character of the bottom (by preference stony) and by the occurrence of certain algæ. Those fishes which are recorded with greatest frequency at the western end of the Sound are mainly species of flounders and skates, which occur predominantly on sandy bottoms. Of the five species thus restricted (*Raja erinacea*, *Lophopsetta maculata*, *Paralichthys oblongus*, and, to a less extent, *Paralichthys dentatus* and *Pseudopleuronectes americanus*), two are predominantly southward ranging, while the other three have ranges which extend about equally in both directions. Thus the character of the bottom in this western area of Vineyard Sound is doubtless responsible directly or indirectly for the distribution of these fishes. The case is quite different from that of many other organisms which have been considered by us, whose presence near the open end of the Sound is to be explained by reference to the lower water temperature which obtains there.

Even if we had a full and accurate knowledge of the local distribution of these various fishes, we should hardly expect to find the same dependence upon temperature conditions as was found in the case of some other organisms. Since fishes are free to move from place to place according to their needs, they are not subject to the constant influence of any set of conditions acting throughout the entire life cycle, as is the case with fixed or slowly moving organisms. It may well be (see pp. 175–177) that the restricting effects of a colder or warmer environment in relation to distribution depend in many instances upon its action during the reproductive period alone, and that the adult organism itself might be able to thrive under conditions unfavorable to its early development or to its reproductive activity. Indeed it is likely that such a possibility is often realized in the case of animals having sufficient powers of locomotion. And it is perhaps among the fishes themselves, many of which migrate to warmer waters for the purposes of reproduction, that the best examples may be found.

The distribution of most fishes within the narrow limits of such a region as the present one is doubtless determined chiefly by the occurrence of their food supply. This we may say with a high degree of probability, although we may not be able to determine many definite cases of correlation between the occurrence of particular species of fishes and the particular organisms which serve as their food. In the case of such predominantly bottom dwelling species as the flounders and the skates, it seems very probable that the character of the bottom is an independent factor in determining distribution. Such fishes require beds of comparatively clear sand, upon which they rest or under which they may find concealment.

The following is a list of the species of fishes recorded during the survey dredging. The asterisk, here as elsewhere, denotes those species which were taken at 10 or more stations.

*Raja erinacea (chart 198).
Gasterosteus aculeatus.
*Syngnathus fuscus (chart 199).
*Ammodytes americanus (chart 200).
Poronotus triacanthus.
Centropristes striatus.
*Stenotomus chrysops (chart 201).
*Tautogolabrus adspersus (chart 202).
Monacanthus hispidus.
*Spheroides maculatus (chart 203).
*Myoxocephalus æneus (chart 204).
Myoxocephalus octodecimspinosus.
Hemitripterus americanus.
Cyclopterus lumpus.
Neoliparis atlanticus.
*Prionotus carolinus (chart 205).
Gobiosoma bosci.
*Pholis gunnellus (chart 206).
Ulvaria subbifurcata.
Zoarces anguillaris.
Merluccius bilinearis.
Urophycis regius.
Urophycis tenuis.
Urophycis chuss.
*Paralichthys dentatus (chart 207).
*Paralichthys oblongus (chart 208).
Limanda ferruginea.
*Pseudopleuronectes americanus (chart 209).
*Lophopsetta maculata (chart 210).
Lophius piscatorius.

The 13 most common species which were taken in the dredge may be grouped as follows in respect to their known geographical range: Predominantly northern, 2; predominantly southern, 5; approximately equal, 6. The ranges for these species will not be stated here, since these are given in the table below, which gives the distribution of all our local species.

Leaving the consideration of these few species which were taken with the dredge and passing to a consideration of the entire array of species which have been reported from the vicinity of Woods Hole, we may say that our local fish fauna is overwhelmingly southern in its character. In the subjoined lists the Woods Hole fishes have been grouped into (1) those which are predominantly northward ranging; (2) those which are predominantly southward ranging; and (3) those which have an approximately equal range in both directions or regarding which the data are not sufficiently known. The distributions here stated are taken in the main from Jordan and Evermann's "Fishes of North and Middle America," supplemented by data published by H. M. Smith and by W. C. Kendall.

It will be seen that only 29 species, or less than 12 per cent of the entire number, are grouped among the northward-ranging forms, while over 75 per cent are grouped among the southward-ranging forms. The remaining 13 per cent can not well be classed in either division, and they have accordingly been grouped by themselves.

Viewing these data in another way, it will be seen that nearly half of the total number of species (48 per cent) have not been recorded from any point north of Cape Cod. In this connection allowance must of course be made for the possibility that the frequent appearance of Cape Cod as the northern limit of distribution, according to published reports, results largely from the circumstance that the fishes of Cape Cod and vicinity have been more fully listed than those of almost any other point on the coast. An equally diligent search of the waters to the northward will probably reveal the presence of many species which have hitherto been supposed to be limited by this barrier.[a]

[a] For example, Kendall (1908) records a number of species for northern New England, which by Jordan and Evermann were not listed for points to the north of Cape Cod.

Again, it is true that a very large number of the species which have been recorded for the Woods Hole region do not really belong to our local fauna at all, but are to be regarded as occasional stragglers which probably follow the Gulf Stream hither from the tropical or semitropical seas. Such without exception are the barracudas (Sphyrænidæ), pompanos (*Trachynotus*), groupers (*Epinephelus*, *Garuppa*, *Mycieroperca*), snappers (*Lutianus*), parrot-fishes (*Scarus*, *Sparisoma*), butterfly-fishes (*Chætodon*), surgeon-fishes (*Teuthis*), trunk-fishes (*Lactophrys*), and the sargassum-fish (*Pterophryne histrio*); together with most of the flying-fishes (*Exocœtidæ*), drums (*Sciænidæ*), and many others.

But the list of southward-ranging species is likewise seen to comprise the greater number of our most familiar local fishes, both the permanent residents and the "migratory" species, which are only observed during half of the year or less.

Of the northern species less than half are taken with any frequency in local waters. To this group belong most of the sticklebacks and sculpins, the lumpsucker and "sea snails," all of the "blenniform" fishes (*Pholis*, *Ulvaria*, *Cryptacanthodes*, *Anarhichas*, *Zoarces*, *Lycodes*), about half of the Gadidæ, three of the flounders, and several others. It is quite likely that in the deep, cold waters offshore other representatives of the northern fish fauna would be taken.

The following table includes all of the identified species comprised in our annotated list, grouped according to their known range as northern or southern.

Species having a predominantly northward range (29).

Myxine glutinosa	North Atlantic, south to Cape Cod; one record off Delaware.
?Cetorhinus maximus	Arctic seas, straying as far as Virginia.
Raja ocellata	Eastport to New York.
Salmo salar	Hudson Bay to Cape Cod; formerly in Hudson River and Delaware River.
Pungitius pungitius	Arctic Sea to Long Island.
Gasterosteus aculeatus	Labrador to New Jersey.
Gasterosteus bispinosus	Bay of Fundy to Woods Hole and perhaps Connecticut.
Tautogolabrus adspersus	Labrador to Sandy Hook.
Sebastes marinus	Greenland to New Jersey.
Myoxocephalus grœnlandicus	Greenland to New York.
Myoxocephalus octodecimspinosus	Labrador to Virginia.
Hemitripterus americanus	Labrador to New York.
Cyclopterus lumpus	North Atlantic south to New York.
Neoliparis atlanticus	Newfoundland to Cape Cod; Woods Hole.
Liparis liparis	Spitzbergen to Connecticut.
Pholis gunnellus	Labrador to Bridgeport, Conn.
Ulvaria subbifurcata	North Atlantic south to Cape Cod; Vineyard Sound.
Cryptacanthodes maculatus	Labrador to Long Island Sound.
Anarhichas lupus	North Atlantic south to Cape Cod; Narragansett Bay.
Zoarces anguillaris	Labrador to Delaware.
Lycodes reticulatus	Greenland to Narragansett Bay.
Pollachius virens	North Atlantic south to Cape Cod; Long Island Sound.
Microgadus tomcod	Labrador to Virginia.
Rhinonemus cimbrius	North Atlantic south in deep water to the Gulf Stream.
Gaidropsarus argentatus	Greenland to Vineyard Sound.
Brosmius brosme	North Atlantic south to Cape Cod; off Newport.
Hippoglossus hippoglossus	Northern seas southward to Sandy Hook.
Hippoglossoides platessoides	North Atlantic south to Cape Cod; Rhode Island.
Limanda ferruginea	Labrador to New York.

Species having a predominantly southward range (190).

Mustelus canis.....Salem, Mass., to Cuba.
Galeocerdo tigrinus.....Cape Cod to tropical seas.
Prionace glauca.....Woods Hole southward; warm seas.
Carcharhinus obscurus.....Nahant to North Carolina.
Carcharhinus milberti.....Cape Cod to Florida.
Carcharhinus limbatus.....Woods Hole (stray specimens) to Brazil.
Sphyrna zygæna.....Cape Cod to warm seas.
Alopias vulpes.....Eastport to warm seas.
Carcharias littoralis.....Casco Bay to North Carolina
Isurus dekayi.....Casco Bay to West Indies.
Carcharodon carcharias.....Eastport to tropical seas.
Squalus acanthias.....Canada to Cuba.
Squatina squatina.....Cape Cod to Florida.
Raja eglanteria.....Gloucester to Florida.
Raja lævis.....Eastport to Florida.
Tetronarce occidentalis.....Casco Bay and perhaps Nova Scotia to Cuba.
Dasyatis centrura.....Coast of Maine to Cape Hatteras.
?Dasyatis hastata.....Chatham to Brazil.
Pteroplatea maclura.....Woods Hole to Brazil.
Myliobatis freminvillei.....Cape Cod to Brazil.
Rhinoptera bonasus.....Cape Cod to Florida.
Acipenser sturio.....Penobscot River to Charleston.
Felichthys marinus.....Cape Cod to Texas.
Galeichthys felis.....Cape Cod to Texas.
Anguilla rostrata.....Gulf of St. Lawrence to Mexico.
Leptocephalus conger.....Maine to Brazil.
Muræna retifera.....Tuckernuck Island to coast of South Carolina.
Tarpon atlanticus.....Buzzards Bay to Brazil.
Elops saurus.....Woods Hole to tropical seas.
Albula vulpes.....Woods Hole to tropical seas.
Etrumeus teres.....Cape Cod to Gulf of Mexico.
Clupanodon pseudohispanicus..Cape Cod to Gulf of Mexico.
Pomolobus mediocris.....Maine to Florida.
Alosa sapidissima.....Gulf of St. Lawrence to Alabama.
Opisthonema oglinum.....Vineyard Sound to West Indies.
Brevoortia tyrannus.....Nova Scotia to Brazil.
Anchovia brownii.....Cape Cod to Brazil.
Anchovia argyrophanus.....Gulf Stream; occasional northward to Woods Hole, Mass.
Anchovia mitchilli.....Casco Bay to Texas.
Trachinocephalus myops.....Woods Hole to Brazil.
Synodus fœtans.....Cape Cod to Brazil.
Fundulus majalis.....Salem to Florida.
Fundulus heteroclitus.....Coast of Maine to Rio Grande.
Lucania parva.....Woods Hole to Key West.
Cyprinodon variegatus.....Cape Cod to Rio Grande.
Tylosurus marinus.....Casco Bay to Texas.
Tylosurus acus.....Buzzards Bay (occasional) to West Indies.
Athlennes hians.....Woods Hole to Brazil.
Hyporhamphus roberti.....Woods Hole to Panama.
Hemirhamphus brasiliensis.....Woods Hole to Brazil.
Euleptorhamphus velox.....Massachusetts to West Indies.
Parexocœtus mesogaster.....West Indies; north in the Gulf Stream to Newport.
Exocœtus rondeletii.....Vineyard Sound to tropical seas.

Exocœtus volitans.....Banks of Newfoundland to West Indies.
Cypselurus heterurus.....Banks of Newfoundland to southern coast of United States.
Cypselurus furcatus.....Cape Cod to warm seas.
Fistularia tabacaria.....Rockport, Mass., to West Indies.
Syngnathus fuscus.....Eastport to North Carolina.
Hippocampus hudsonius.....Massachusetts Bay? to Charleston.
Menidia beryllina cerea.....Sandwich, Mass., to South Carolina.
Mugil cephalus.....Casco Bay to Brazil.
Mugil curema.....Cape Cod to Brazil.
Sphyræna barracuda.....Woods Hole to Brazil.
Sphyræna guachancho.....Woods Hole (occasional) to West Indies.
Sphyræna borealis.....Cape Cod to Cape Fear.
Polydactylus octonemus.....Woods Hole to the Rio Grande.
Holocentrus tortugæ.....(?)
Mullus auratus.....Cape Cod to Pensacola, Fla.
Auxis thazard.....Cape Cod (occasional) to warm seas.
Gymnosarda pelamis:.....Cape Cod to warm seas.
Gymnosarda alleterata.....Cape Cod (occasional) to West Indies.
Thunnus thynnus.....Newfoundland to Caribbean Sea.
Germo alalunga.....Woods Hole to tropical seas.
Sarda sarda.....Harpswell, Me., to Hatteras.
Scomberomorus maculatus.....Maine to Brazil.
Scomberomorus regalis.....Cape Cod to Brazil.
Scomberomorus cavalla.....Cape Cod to Brazil.
Trichiurus lepturus.....Maine to West Indies.
Istiophorus nigricans.....Woods Hole to West Indies.
Tetrapterus imperator.....Cape Cod (occasional) to West Indies.
Xiphias gladius.....Cape Breton to Cuba.
Oligoplites saurus.....Woods Hole to West Indies.
Naucrates ductor.....Maine to West Indies.
Seriola zonata.....Salem, Mass., to Cape Hatteras.
Seriola lalandi.....Woods Hole to Brazil.
Seriola dumerili.....Woods Hole to West Indies.
Decapterus punctatus.....Cape Cod to Brazil.
Decapterus macarellus.....Cape Cod to warm parts of Atlantic.
Trachurus trachurus.....Newport; Pensacola.
Trachurops crumenophthalmus.Cape Cod (occasional) to West Indies.
Carangus bartholomæi.....Woods Hole to West Indies.
Carangus hippos.....Lynn to tropical America.
Carangus crysos.....Ipswich Bay, Mass., to Brazil.
Alectis ciliaris.....Cape Cod to tropical America.
Vomer setipinnis.....Maine to Brazil.
Selene vomer.....Casco Bay to Brazil.
Trachinotus falcatus.....Cape Cod to Brazil.
Trachinotus goodei.....Woods Hole to West Indies.
Trachinotus argenteus.....Woods Hole to West Indies.
Trachinotus carolinus.....Cape Cod to Gulf of Mexico.
Rachycentron canadus.....Cape Cod to warm seas.
Nomeus gronovii.....Woods Hole to tropical Atlantic.
Coryphæna hippurus.....Cape Cod to Texas.
Palinurichthys perciformis.....Maine to Cape Hatteras.
Peprilus paru.....Cape Cod to Brazil.
Poronotus triacanthus.....Nova Scotia to Florida.
Apogon imberbus.....Mediterranean and neighboring waters; Brazil.
Apogon maculatus.....Marthas Vineyard to Brazil.

Roccus lineatus.....New Brunswick to Florida.
Morone americana.....Nova Scotia to South Carolina.
Epinephelus adscensionis.....Marthas Vineyard to Brazil.
Epinephelus niveatus.....Woods Hole to Brazil.
Epinephelus morio.....Marthas Vineyard to Brazil.
Garrupa nigrita.....Marthas Vineyard to Brazil.
Mycteroperca bonaci.....Marthas Vineyard to Brazil.
?Mycteroperca interstitialis.....Marthas Vineyard to Cuba.
Centropristes striatus.....Maine to Florida.
Rypticus bistrispinus.....Newport to Key West.
Lobotes surinamensis.....Cape Cod to warm seas.
Priacanthus arenatus.....Woods Hole to Brazil.
Pseudopriacanthus altus.....Marblehead, Mass., to West Indies.
Lutianus griseus.....Woods Hole to Brazil.
Lutianus jocu.....Woods Hole (occasional) to Brazil.
Lutianus apodus.....Woods Hole (rare) to Brazil.
Lutianus blackfordii.....Woods Hole (occasional) to Brazil.
Lutianus analis.....Woods Hole (occasional) to Brazil.
Ocyurus chrysurus.....Marthas Vineyard to Brazil.
Orthopristis chrysopterus.....Marthas Vineyard to Rio Grande.
Stenotomus chrysops.....Eastport, Me., to South Carolina.
Lagodon rhomboides.....Cape Cod to Cuba.
Archosargus probatocephalus...Cape Cod to Texas.
Eucinostomus gula.....Woods Hole to Brazil.
Kyphosus sectatrix.....Cape Cod to West Indies.
Kyphosus incisor.....Nantucket to Brazil.
Cynoscion regalis .....Maine to Gulf of Mexico.
Larimus fasciatus.....Woods Hole (occasional) to Texas.
Sciænops ocellatus.....Buzzards Bay to Texas.
Leiostomus xanthurus.....Cape Cod to Texas.
Micropogon undulatus.....Cape Cod to Texas.
Menticirrhus saxatilis.....Casco Bay to Florida.
Pogonias cromis.....Provincetown to Rio Grande.
Eupomacentrus leucostictus....Marthas Vineyard to West Indies.
Abudefduf saxatilis.....Newport to Uruguay.
Tautoga onitis.....New Brunswick to Charleston, S. C.
Sparisoma flavescens.....Woods Hole to Rio Janeiro.
Scarus croicensis.....Marthas Vineyard to West Indies.
Chætodipterus faber.....Cape Cod to Rio Janeiro.
Chætodon ocellatus.....Woods Hole to West Indies.
Chætodon capistratus.....Woods Hole to West Indies.
Teuthis cæruleus.....Marthas Vineyard to Brazil.
Teuthis hepatus.....Marthas Vineyard to Brazil.
Teuthis bahianus.....Marthas Vineyard to Brazil.
Balistes carolinensis.....Annisquam, Mass., to tropical Atlantic.
Balistes vetula.....Woods Hole (occasional) to West Indies.
Balistes forcipatus.....Newport (?) to Brazil.
Canthidermis sobaco.....Vineyard Sound to West Indies.
Monacanthus hispidus.....Lynn, Mass., to Brazil.
Alutera schœpfii.....Portland, Me., to Texas.
Alutera monoceros.....Woods Hole to West Indies.
Lactophrys triqueter.....Marthas Vineyard to West Indies.
Lactophrys trigonus.....Woods Hole to West Indies.
Lactophrys tricornis.....Marthas Vineyard to tropical Atlantic.
Lagocephalus lævigatus.....Cape Cod to Brazil.

Spheroides spengleri.....Woods Hole to Rio Janeiro.
Spheroides maculatus.....Casco Bay to Florida.
Spheroides testudineus.....Newport to West Indies.
Diodon hystrix.....Buzzards Bay to tropical seas.
Chilomycterus schœpfi.....Massachusetts Bay to Florida.
Chilomycterus antillarum .....Woods Hole; Cuba and Jamaica.
Mola mola.....Off Portland, Me., to tropical seas.
Scorpæna plumieri.....Marthas Vineyard to Brazil.
Scorpæna grandicornis.....Marthas Vineyard to Brazil.
Prionotus carolinus.....Maine to South Carolina.
Prionotus strigatus.....Salem, Mass., to Virginia.
Cephalacanthus volitans.....Maine to Gulf coast.
Gobius stigmaticus.....Marthas Vineyard to Rio Janeiro.
Gobiosoma bosci.....Cape Cod to Florida.
Echeneis naucrates.....Salem, Mass., to warm seas.
Remora remora.....Salem to West Indies.
Remora brachyptera.....Massachusetts Bay to warm seas.
Rhombochirus osteochir.....Cape Cod to West Indies.
Lopholatilus chamæleonticeps..Deep waters of the western Atlantic.
Opsanus tau.....Massachusetts Bay, perhaps Maine, to Cuba.
Macrourus bairdii.....Eastport to West Indies.
Paralichthys dentatus.....Casco Bay to Florida.
Lophopsetta maculata.....Eastport to South Carolina.
Platophrys ocellatus.....Marthas Vineyard to Rio Janeiro.
Achirus fasciatus.....Cape Ann to Texas.
Gymnachirus nudus.....Woods Hole; Brazil.
Pterophryne histrio.....Woods Hole to tropical Atlantic.

Species having an approximately equal range to the north and south, and ones whose range is not definitely known (32).

Petromyzon marinus.....Eastport to North Carolina.
?Lamna cornubica.....North Atlantic; occasionally taken on coast of New England and southward.
Raja erinacea.....Maine to Virginia.
Raja radiata.....North Atlantic.
Clupea harengus.....North Atlantic Ocean, chiefly north of Cape Hatteras.
Pomolobus pseudoharengus.....Atlantic coast of the United States.
Pomolobus æstivalis.....Atlantic coast; Eastport; Southern States.
Salvelinus fontinalis.....Labrador to Georgia.
Osmerus mordax.....Gulf of St. Lawrence to Virginia.
Maurolicus pennanti.....Open seas, occasionally off New England coast.
Fundulus diaphanus.....Coast of Maine to Cape Hatteras.
Scombresox saurus.....Newfoundland to Beaufort.
Cypselurus gibbifrons.....Only two specimens known.
Apeltes quadracus.....Maine to New Jersey.
Menidia menidia notata.....Nova Scotia to North Carolina.
Ammodytes americanus.....Newfoundland to Cape Hatteras.
Scomber scombrus.....Labrador to Cape Hatteras.
Scomber colias.....Maine; England to Mediterranean; Pacific Ocean.
Pomatomus saltatrix.....Atlantic and Indian Oceans, widely distributed.
Brama raii.....Open seas, widely distributed.
Centrolophus niger.....Coasts of southern Europe.
Tetragonurus cuvieri.....Open Atlantic; off Toulon and Marseilles and near Madeira.
Myoxocephalus æneus.....Casco Bay to New York.
Merluccius bilinearis.....Straits of Belle Isle to Bahamas.

Gadus callarias.....North Atlantic, south to Virginia; North Carolina.
Melanogrammus æglefinus.....North Atlantic, south to North Carolina.
Urophycis regius.....North Atlantic, south to Charleston, S. C.
Urophycis tenuis.....Banks of Newfoundland to Cape Hatteras.
Urophycis chuss.....Gulf of St. Lawrence to Virginia.
Paralichthys oblongus.....Coasts of New England and New York.
Pseudopleuronectes americanus.Labrador to Chesapeake Bay; Georgia.
Lophius piscatorius.....Nova Scotia, in deep water, to Barbados.

13. REPTILIA, AVES, MAMMALIA.

These groups have been included in our catalogue for the sake of completeness, though they occupy a very different position in our marine fauna from any of the groups which have thus far been discussed.

Of the reptiles, five species have been listed, of which only three are to be regarded as marine in the strict sense of the word. These are the sea turtles, which are occasionally taken in fish traps or otherwise during the summer months. We are indebted to Dr. Leonhard Stejneger for criticizing our manuscript list of Reptilia and for aiding us in the identification of one species.

Of the birds, only swimming species which are known to frequent salt water have been listed. In some cases it has not been easy to decide whether or not a given bird should be regarded as "marine." In the preparation of this list we have received much help from Dr. G. M. Allen and Prof. Lynds Jones. Dr. Allen has kindly examined the manuscript of our check list. The nomenclature of the American Ornithologists' Union has been adopted without modification. In the preparation of this list, as in many other parts of our work, we have received substantial assistance from Mr. Vinal Edwards, who has for many years collected birds at Woods Hole.

With the exception of the muskrat, mink, and seals, the mammals of our list are all Cetacea. The source of these records has been indicated in the list itself. Very few of these animals are seen with any frequency in the neighborhood of Woods Hole. Indeed some of the whales have not been noted within the region for many years. We are indebted to Dr. F. W. True for a number of the records for species, as well as for criticizing our manuscript.